

THE ASTROPHYSICAL JOURNAL

AN INTERNATIONAL REVIEW OF SPECTROSCOPY
AND ASTRONOMICAL PHYSICS

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APRIL 1931

THE THREE ACTINOID SECOND SERIES, ZONE $+75^{\circ}$ TO $+60^{\circ}$ AND -10° TO -25° 121

A STUDY OF THE WIDTHS OF THE LINES IN THE B BAND, DUE TO ATOMIC
EMISSIVE COEFFICIENTS IN THE SOLAR SPECTRUM 125

NOTE ON THE CORRELATION OF SPECTROPHOTOMETRIC OBSERVATIONS
OF WEAK SPECTRAL LINES 129

UNIVERSITY OF CHICAGO PRESS
CHICAGO, ILLINOIS, U.S.A.

THE ASTROPHYSICAL JOURNAL

AN INTERNATIONAL REVIEW OF SPECTROSCOPY AND
ASTRONOMICAL PHYSICS

VOLUME LXXIII

APRIL 1931

NUMBER 3

THE YERKES ACTINOMETRY, SECOND SERIES

ZONE $+75^{\circ}$ TO $+60^{\circ}$

BY ARTHUR S. FAIRLEY

ABSTRACT

The photographic magnitudes of 2354 stars were determined by means of extra-focal images and an absolute scale.

The zero point was determined from the stars from the Potsdam Photometric Durchmusterung on each plate.

Probable errors for 532 stars were found and classified in various ways.

Color indices were found from these magnitudes and those of the H.R.

Professor J. A. Parkhurst in "The Yerkes Actinometry"¹ gave a catalogue of the stars of the *Potsdam Photometric Durchmusterung*² in the zone $+90^{\circ}$ to $+73^{\circ}$ declination, down to magnitude 7.5, for which he had determined the photographic and photovisual magnitudes and the spectral types. It seemed desirable to Professor E. B. Frost, director of the Yerkes Observatory, that this work be continued. Accordingly, he sought a grant for this purpose from the Rosenwald Fund of the University of Chicago, which was very kindly given. The writer came to the Yerkes Observatory in June, 1928, and in July of that year began the systematic photographing and reducing which has resulted in the accompanying catalogue. It was decided to lower the limit of brightness of the stars included to $8^m.25$, and to concentrate on photographic magnitudes. Therefore this catalogue contains the photographic magnitudes of stars down to $8^m.25$, and from $+75^{\circ}$ to $+60^{\circ}$ declination.

¹ *Astrophysical Journal*, **36**, 169, 1912.

² *Publicationen des Astrophysikalischen Observatoriums zu Potsdam*, **17**, 1907.

The instrument used is the Zeiss 14.5-cm doublet of 81-cm focal length made of UV glass, which is particularly transparent to the near ultra-violet. The useful field of the instrument is $6^{\circ}.4$. Plates were taken in the same manner in which Parkhurst took them, 6 mm inside the focus for photographic light, where the images are a little over a millimeter in diameter, and of a remarkably uniform density, as may be seen from Plate II. About 1000 plates were taken for this zone: 925 by the writer, 50 by R. G. Barton, and 25 by A. W. Recht. The plates used were Eastman 40's and the usual exposure time was twenty-five minutes. The plates were developed in Eastman D-11 developer for six minutes at 20° C. The fields were centered at $+73^{\circ}$, $+71^{\circ}$, $+69^{\circ}$, $+67^{\circ}$, $+65^{\circ}$, $+62^{\circ}$, and $+59^{\circ}$ declination, and every twenty minutes in right ascension. The average number of plates upon which each star appeared was 6. The plates were taken as nearly as possible at the altitude of the pole.

The plates were measured in the Hartmann microphotometer, one setting being made on each image. It was found that this instrument gave much more accurate results when both the plate and the wedge were enough out of focus in the same direction so that the grain of neither showed. At the beginning of the work more than one setting was made on each image, but when the observer acquired some skill it was found that the settings repeated themselves so uniformly that all but one were eliminated.

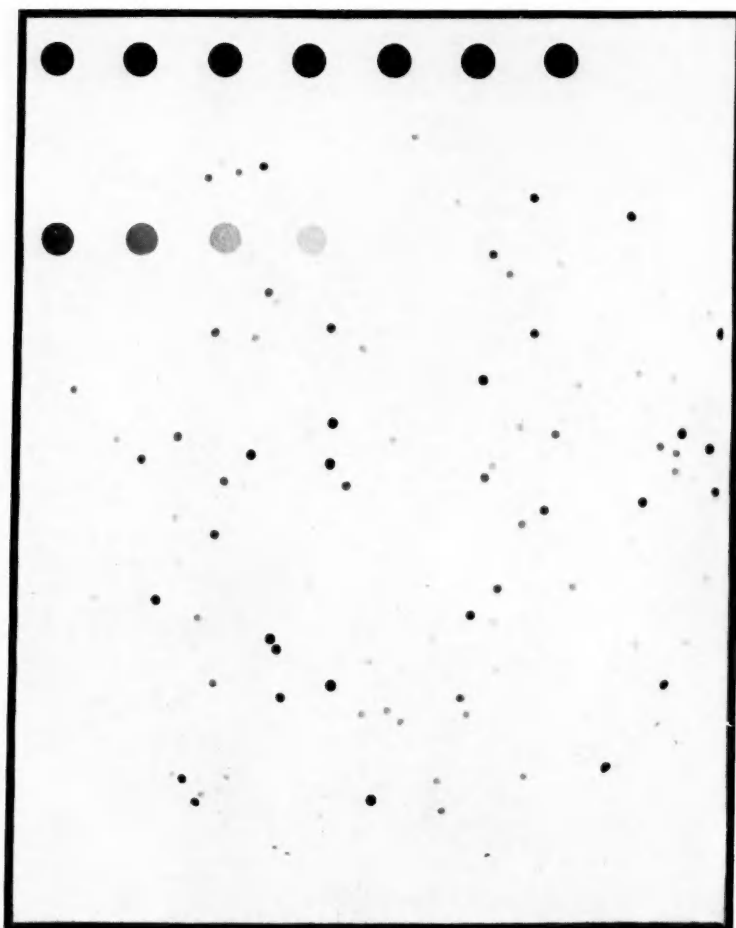
ZERO POINT AND SCALE

On each plate there were several stars from the *Potsdam Photometric Durchmusterung*, whose spectra, from the *Henry Draper Catalogue*, were between B5 and A5. The Potsdam visual magnitudes of all such stars on a plate were corrected for color index to A0 according to the following table derived from the work of E. S. King.¹

Sp.	Corr.	Sp.	Corr.
B5.....	-0 ^m .20	A0.....	0 ^m .00
B8.....	.07	A2.....	+ .08
B9.....	-0.04	A3.....	.11
		A5.....	+0.20

¹ *Harvard Annals*, 59, 157, 1912.

PLATE II



EXTRA-FOCAL PLATE SHOWING STAR IMAGES AND SENSITOMETER DISKS
The three fainter sensitizer areas were lost in reproduction

The mean of these corrected magnitudes was then taken and a further correction of $-0^m.28$ was applied to change from the zero point of the Potsdam scale to that of the international scale. The resulting magnitude gave the zero point for the plate in question. This calculation was made for each plate. The number of such so-called standard stars averaged 6.2 per plate, the maximum number being 22 and the minimum 1. These stars are designated by S in the column of "Remarks" of the catalogue.

After each plate was exposed in the telescope and before it was developed, it was exposed in a sensitometer which impressed on it areas of standard intensity. The sensitometer consists of a metal plate containing fourteen holes of accurately known size, the apertures decreasing in size progressively from one end to the other. This plate is illuminated by an electric lamp shining through several pieces of opal glass, so that the illumination is uniform over the whole area. Several inches from the first plate is another metal plate with fourteen holes of 4.5-mm diameter whose centers correspond with the centers of the holes in the first plate. Between the two plates are cells containing diaphragms which reduce internal reflections. The photographic plate is placed in contact with the metal plate having the uniform holes, and the light is turned on for a sufficient length of time to cause the formation of images of a suitable density for measuring. The relative density of each image will depend solely upon the area of the original hole, and as these areas are accurately known, the series of sensitometer images forms a completely independent scale except for local variations in the emulsion of the individual photographic plate (see Plate II).

REDUCTION OF PLATES

When the plates are measured in the Hartmann microphotometer, the sensitometer images are measured in exactly the same way as those of the stars. It is then possible to plot the scale readings against values of the relative magnitudes of the sensitometer images and to draw a smooth curve through the points. The relative magnitude of each star on the plate is then read from this curve by means of the microphotometer setting, and the zero point of the plate determined as explained above. Thus each plate by itself is an independent

determination, having its own scale and zero point without reference to any other plate. The wedge simply forms a link between the images of the stars and the sensitometer disks; thus its "constant" is entirely unimportant.

CORRECTIONS

1. *Correction to the center of the plate.*—A series of equal exposures of the same star at varying distances from the center of a plate was made, and from the differences in their opacity corrections to the center of the plate were found as follows:

Distance from the Center in Degrees	Corr.	Distance from the Center in Degrees	Corr.
0°.5.....	0 ^m .01	2°.0.....	0 ^m .14
1.0.....	.03	2.5.....	.22
1.5.....	0.08	3.0.....	.30
		3.2.....	0.34

Stars farther than 3°.2 from the center were not measured. These corrections were confirmed by the measures of stars appearing on more than one plate.

No correction for sky fog on the plates was found necessary, as the sensitometer images were superimposed on this fog in exactly the same manner as were the star images, so that both were equally affected. Local variations in density of the background, owing to non-uniformity of the emulsion of the plate, were usually found too small to be measured.

2. *Correction for atmospheric absorption.*—The only correction for atmospheric absorption necessary is a very small one to reduce each star to the center of the plate. For this the values of C. Wirz¹ were used. Since the magnitudes of the Potsdam stars used as standards are reduced to the zenith already, magnitudes derived from them will need no further correction for absorption.²

WEIGHTS IN FINAL CATALOGUE

The individual determinations of the magnitudes of each star were weighted according to the distance of the image from the center of the plate. This was done because of the progressive loss of uni-

¹ *Astronomische Nachrichten*, 154, 349, 1900.

² For Parkhurst's color corrections for this instrument see this *Journal*, 36, 181, 1912.

formity of the images at increasing distances from the center. The weights were assigned as follows:

Distance from Center	Weight	Distance from Center	Weight
$0^{\circ}0-1^{\circ}5$	6	$2^{\circ}4-2^{\circ}7$	3
$1.5-2.0$	5	$2.7-3.0$	2
$2.0-2.4$	4	$3.0-3.2$	1

The weighted mean of the individual determinations is the magnitude in the catalogue. No star is included in the catalogue unless it was measured on at least two plates.

ACCURACY OF RESULTS

The probable errors were determined for 532 stars chosen at random from the total number. The mean for all of them is ± 0.033 .

The number of plates on which each star appeared varied from 2 to 14, the average being 5.9. Probable errors classified according to the number of plates are as follows:

No. of plates....	2	3	4	5	6	7	8	9	10	11	12
P.E. ± 0.....	.049	.039	.038	.036	.034	.021	.021	.018	.019	.014	.016

Probable errors classified according to magnitude:

Magnitude	> 5.0	5.0-5.5	5.5-6.0	6.0-6.5	6.5-7.0	7.0-7.5	7.5-8.0	8.0-8.5	8.5 and fainter
P.E. ± 0...	.044	.016	.024	.023	.023	.029	.035	.033	.036
No. of stars	12	4	8	16	20	36	100	180	156

Leaving out the groups brighter than 5.0 and fainter than 8.5 reduces the mean probable error to ± 0.032 , which is identical with that obtained by Parkhurst.

The spectrum of each star is taken from the *Henry Draper Catalogue*, and the probable errors classified according to spectral type are as follows:

Spectral type.....	B	A	F	G	K	M
P.E. ± 0.....	.035	.035	.030	.036	.035	.043

It is interesting to note the decided increase in probable error for the red stars. This may be due to the fact, found by J. Stebbins,¹ that there is a large number of irregular variables of small range among these stars.

By combining the photographic magnitudes of this catalogue with the visual magnitudes of the *H.R.* color indices may be found. Such color indices, of course, will combine the accidental and scale errors of both catalogues as well as the errors of spectral classification, and

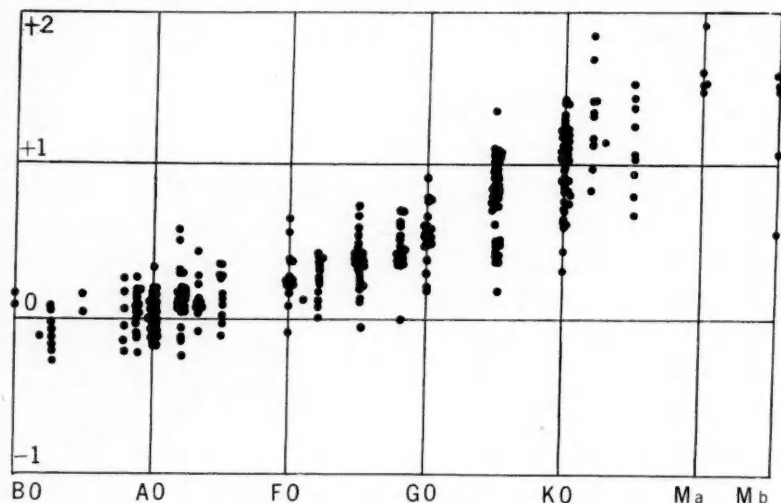


FIG. 1.—Color indices and spectral type

so would be expected to have a rather large scattering. The scattering actually found, however, is much larger than can be accounted for by this means, and leads to the conclusion, found recently by F. E. Ross and R. S. Zug,² that the relation between color index and spectral type is at best an approximate one.

The table on page 131 shows the mean color index, Yerkes-*H.R.*, for each spectral type.

Figure 1 shows the scattering which is found. The stars plotted are those from zero to three hours, and from twelve to fifteen hours of right ascension. The size of the circle representing each star is ap-

¹ *Publications of the Washburn Observatory*, 15, Part 3, 139, 1930.

² *Astronomische Nachrichten*, 239, 289, 1930.

proximately equal to the probable error of the photographic magnitude.

At this writing 8/10 of the plates necessary for the continuation of this work from $+60^{\circ}$ to $+45^{\circ}$ have been obtained, and the reductions are in progress.

	0	2	3	5	8	9
B.....	+0.1	-0.1	-0.11	-0.10	-0.03	-0.01
A.....	.00	+ .03	+0.06	+ .10		
F.....	.20	0.23		.32	+0.41	
G.....	0.50			0.75		
K.....	1.00	+1.10		+1.26		
Ma.....	+1.55		{ Mb +1.60 }			

I wish to thank Professor Edwin B. Frost for his kind assistance at all stages of this work. I am particularly indebted to my wife for much valuable assistance in computation and in preparing the tables.

YERKES OBSERVATORY

January 26, 1931

CATALOGUE OF ZONE +75° TO +60°

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
68° 1426.....	0 ^h 0 ^m 1	68° 19'	6.98	B9	7.01	7	S
62 2362.....	0 0.9	63 07	.....	B	7.29	3	
65 2001.....	0 1.7	65 52	.....	F0	8.33	2	
71 1250.....	0 1.8	72 13	.....	A3	8.47	11	
72 1140.....	0 1.9	72 39	.....	F2	8.07	9	
70 1.....	0 2.8	70 36	.....	A0	8.35	9	
62 5.....	0 3.3	62 39	6.59	G5	7.36	6	
73 2.....	0 3.4	73 39	7.42	A0	7.39	9	S
64 3.....	0 3.9	64 32	7.02	K0	7.90	7	
64 5.....	0 4.7	65 11	7.95	A0	7.80	7	
63 5.....	0 4.9	64 05	.....	K0	9.33	5	
73 4.....	0 5.9	73 56	7.10	K0	8.20	8	
65 13.....	0 6.5	65 34	7.15	A0	7.25	5	S
67 5.....	0 6.8	67 52	.....	A2	8.46	4	
67 6.....	0 7.8	67 37	.....	F5	8.50	6	
61 16.....	0 7.9	61 29	6.59	A0	6.59	5	S
67 7.....	0 8.2	67 30	.....	F0	8.37	8	
64 15.....	0 8.4	64 18	7.92	G0	8.11	7	
65 21.....	0 8.9	65 47	.....	A3	8.00	4	
59 16.....	0 8.9	60 10	7.76	A0	8.08	5	
63 15.....	0 9.4	64 00	.....	A2	8.10	6	
60 16.....	0 10.6	60 27	6.62	G5	7.13	5	
62 38.....	0 11.6	63 00	.....	A0	7.63	5	
60 21.....	0 11.6	60 59	5.80	G5	6.51	6	
75 6.....	0 11.8	75 35	8.57	A0	8.81	4	
62 40.....	0 12.0	62 16	.....	A0	8.10	5	Var.?
72 15.....	0 12.6	72 24	7.50	A3	7.66	10	S
75 7.....	0 12.8	75 43	7.12	B9	7.20	4	S
60 25.....	0 12.9	61 10	.....	B0	7.52	6	
61 32.....	0 13.1	61 39	7.13	K5	8.23	6	
66 15.....	0 13.2	66 45	7.93	A0	7.83	8	S
62 48.....	0 13.5	62 44	7.58	F0	7.67	5	
72 17.....	0 13.7	72 34	7.34	K0	8.37	9	
61 38.....	0 14.6	61 31	.....	B2	7.78	6	
68 14.....	0 14.8	68 18	7.64	F2	7.78	8	
66 19.....	0 15.4	67 07	.....	G5	8.37	7	
62 58.....	0 15.4	63 07	.....	G0	8.58	2	
67 27.....	0 16.2	67 16	6.74	K0	7.49	9	
60 37.....	0 16.2	61 8	.....	F8	7.42	6	
70 10.....	0 16.3	70 41	.....	A2	8.45	10	
74 8.....	0 16.6	74 31	.....	A5	8.94	5	
70 12.....	0 16.6	70 57	7.78	K2	9.30	3	
61 48.....	0 16.6	61 38	.....	B3	7.91	5	
61 50.....	0 17.4	61 41	.....	B3	7.69	5	
64 36.....	0 17.8	64 48	7.39	F0	8.07	7	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
65° 48.....	0 ^h 18 ^m 1	65° 39'	8.40	Fo	8.31	5	
60 45.....	0 18.4	60 23	6.75	F2	6.75	7	
63 38.....	0 18.6	63 45	.....	B9	8.31	4	
61 69.....	0 19.3	61 17	5.39	B9	5.43	5	
71 16.....	0 20.1	71 15	6.94	B2	6.82	11	
64 44.....	0 20.3	64 50	7.55	B9	7.44	10	S
63 52.....	0 23.6	63 42	.....	Ao	8.24	5	
74 14.....	0 23.9	74 41	.....	Ko	9.05	5	
61 94.....	0 24.0	61 31	.....	Ko	7.83	5	
68 25.....	0 24.1	68 32	.....	A2	7.46	2	
71 19.....	0 24.4	72 00	.....	Ao	9.24	4	
63 53.....	0 24.6	64 12	7.16	Ao	7.08	8	S
64 52.....	0 24.7	64 43	.....	B	8.30	9	
61 101.....	0 25.1	61 48	7.31	B3	7.00	5	
68 29.....	0 25.2	69 14	7.41	F8	7.72	10	
63 55.....	0 25.2	63 31	.....	F8	8.13	5	
65 67.....	0 25.7	65 58	6.14	B5	6.18	8	S
67 50.....	0 26.2	67 27	.....	Fo	8.06	10	
66 35.....	0 26.3	66 36	.....	B8	8.13	9	
70 24.....	0 27.4	70 25	6.36	Ao	6.55	10	S
74 20.....	0 27.7	74 56	.....	Ao	8.55	4	
59 76.....	0 27.9	60 00	7.66	B9	7.56	4	
65 70.....	0 28.6	66 12	6.42	B9	6.41	10	S
66 39.....	0 28.8	66 57	7.31	A3	7.39	10	S
62 107.....	0 28.8	62 22	7.51	F5	7.70	3	
68 35.....	0 29.4	69 12	.....	B9	8.42	4	
74 22.....	0 30.2	74 59	.....	G5	9.04	4	
68 38.....	0 30.6	68 44	.....	Go	8.41	8	
62 116.....	0 30.6	62 40	.....	Ao	8.03	3	
69 29.....	0 30.7	70 01	8.26	F8	8.25	7	
67 57.....	0 30.8	68 08	.....	Fo	8.37	8	
72 35.....	0 31.6	72 21	7.06	B3	6.96	9	
62 130.....	0 34.1	62 41	7.70	F5	7.90	5	
60 32.....	0 34.3	70 10	7.17	Ao	7.23	10	S
65 81.....	0 35.6	65 19	7.10	F8	7.34	8	
66 53.....	0 35.7	67 14	.....	Fo	8.38	6	
65 83.....	0 36.1	65 36	5.92	G5	6.95	8	
73 30.....	0 36.4	73 31	.....	B9	8.19	7	
63 81.....	0 36.9	63 45	7.40	B5	7.58	5	S
61 152.....	0 37.0	62 13	.....	Ao	7.61	5	
70 43.....	0 37.8	70 17	6.49	Ko	7.64	8	
66 55.....	0 38.4	66 28	.....	F8	8.26	8	
64 75.....	0 38.5	64 46	.....	Ao	8.05	10	
66 58.....	0 38.7	66 37	6.85	F8	7.16	8	
74 27.....	0 39.2	74 26	5.59	A2	6.14	5	S

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
61° 165.....	0 ^h 39 ^m 2	61° 59'	6.84	Ko	7.09	5	
65 88.....	0 39.8	65 57	.....	Go	7.73	7	
68 49.....	0 40.3	68 47	6.42	F2	6.81	8	
72 38.....	0 40.5	72 33	.....	Ko	8.85	5	
75 42.....	0 41.1	76 00	8.47	Ao	8.48	3	
74 29.....	0 41.1	74 18	5.39	B8	5.67	5	S
71 37.....	0 41.6	72 08	6.04	Ko	7.08	10	
64 82.....	0 42.2	64 34	7.06	G5	7.68	7	
67 41.....	0 43.0	67 55	.....	B8	7.99	9	
69 45.....	0 43.2	69 54	7.99	Ko	8.30	8	
72 42.....	0 43.4	73 02	.....	Ao	8.83	4	
71 41.....	0 43.6	71 21	7.01	B9	6.77	8	S
70 53.....	0 43.7	70 38	7.39	B9	7.45	9	S
64 84.....	0 43.7	64 33	.....	A5	7.93	7	
62 153.....	0 43.8	62 16	.....	A5	8.12	6	
63 101.....	0 45.1	63 47	.....	A2	8.08	6	
68 56.....	0 45.3	68 26	.....	A2	7.83	8	
61 178.....	0 45.3	61 16	6.36	K2	8.09	4	
62 160.....	0 45.4	63 14	7.06	B3	7.11	6	
70 57.....	0 45.8	71 06	8.00	G5	8.82	4	
68 57.....	0 46.4	68 20	7.12	A2	7.25	8	S
65 103.....	0 46.4	65 21	8.33	A2	8.02	8	
73 40.....	0 46.5	73 46	7.56	A5	7.82	7	S
69 50.....	0 46.9	69 25	7.36	Mb	8.39	2	
63 105.....	0 46.9	63 25	7.36	Mb	7.87	6	
60 124.....	0 47.1	60 34	4.93	F8	5.62	4	
71 41.....	0 47.3	71 21	.....	Ao	9.00	4	
59 134.....	0 47.5	60 08	7.81	A2	7.60	4	S
65 106.....	0 47.9	65 54	7.06	Fo	7.24	8	
60 130.....	0 49.0	60 08	.....	B9	8.16	4	
63 112.....	0 49.1	64 01	7.54	A3	7.57	5	
65 110.....	0 50.0	65 53	.....	Ao	7.86	8	
63 114.....	0 50.0	63 18	.....	Ko	8.62	3	
69 54.....	0 50.1	69 55	.....	A2	8.30	7	
60 135.....	0 50.2	60 43	7.96	Ao	7.87	4	
67 81.....	0 50.4	68 15	6.38	Fo	6.75	7	
74 40.....	0 50.5	74 45	.....	F	9.00	4	
75 45.....	0 50.7	75 28	8.72	A2	8.95	4	
63 117.....	0 50.7	64 00	7.23	F2	7.82	7	
74 41.....	0 50.8	74 57	.....	Ao	7.65	4	
70 61.....	0 51.1	70 53	.....	F5	9.02	3	
60 137.....	0 51.2	60 53	6.62	G5	7.40	4	
69 55.....	0 51.6	69 57	6.86	B9	6.81	9	S
64 107.....	0 51.6	64 51	.....	Ao	8.15	10	
63 118.....	0 52.1	63 35	.....	Ao	8.58	6	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
65° 115.....	0 ^h 52 ^m 2	65° 49'	6.00	B9	6.00	6	S
62 175.....	0 52.2	63 11	.....	B2	7.93	6	
66 79.....	0 52.3	66 55	.....	F2	8.29	11	
72 53.....	0 52.6	72 16	.....	A2	8.97	4	
68 63.....	0 53.7	68 49	.....	A0	8.19	6	
70 65.....	0 53.8	70 26	6.46	A0	6.61	10	S
72 55.....	0 54.1	73 09	.....	A3	8.70	5	
64 109.....	0 54.3	64 37	.....	B9	8.14	10	
62 181.....	0 54.3	62 30	.....	B8	8.20	5	
69 61.....	0 54.9	70 00	7.84	F5	7.92	8	
68 64.....	0 54.9	68 49	6.67	B9	6.65	8	S
65 120.....	0 55.0	65 20	8.20	G5	8.36	5	
65 123.....	0 55.3	65 42	.....	Go	8.51	3	
62 185.....	0 55.6	63 04	.....	F0	8.21	6	
70 70.....	0 56.0	70 30	.....	A0	8.10	10	
68 67.....	0 56.2	68 42	.....	G5	8.16	6	
73 50.....	0 56.3	73 38	.....	F5	8.62	5	
69 63.....	0 56.4	69 47	7.97	A0	7.93	8	
61 196.....	0 56.5	62 05	.....	K0	8.21	5	
72 58.....	0 56.7	72 20	.....	A2	8.96	4	
64 116.....	0 56.7	64 18	.....	F8	8.39	6	
70 72.....	0 57.0	70 53	.....	F5	9.22	3	
62 191.....	0 57.4	63 09	.....	Go	8.23	6	
60 157.....	0 57.4	60 32	5.94	F0	6.52	6	
73 51.....	0 57.6	73 50	6.78	A0	6.99	8	S
68 70.....	0 58.6	68 27	.....	A0	8.14	5	
62 194.....	0 59.0	63 12	.....	Go	8.36	6	
70 73.....	0 59.3	70 40	.....	A0	9.19	3	
65 129.....	0 59.4	65 26	7.10	B8	7.22	8	S
62 195.....	0 59.4	62 20	.....	F0	8.14	7	
60 162.....	0 59.7	60 15	8.21	A0	8.29	5	
65 130.....	1 0.0	65 55	.....	A0	8.35	6	
61 206.....	1 0.0	62 14	6.44	A3	6.52	5	S
70 78.....	1 0.2	70 24	6.64	A2	6.79	9	S
68 72.....	1 0.2	68 18	.....	A0	8.40	6	
63 139.....	1 0.3	63 54	.....	Go	7.78	6	
62 203.....	1 1.2	63 10	.....	G5	8.41	4	
69 70.....	1 1.8	70 10	7.54	A0	7.37	9	
62 209.....	1 2.3	63 10	.....	Go	8.29	5	
68 74.....	1 2.4	69 10	.....	Bo	7.00	8	
60 170.....	1 3.2	61 01	.....	Go	8.35	5	
63 146.....	1 3.8	64 07	.....	A0	7.97	5	
68 77.....	1 3.9	68 15	5.34	A0	5.54	5	S
61 218.....	1 3.9	61 17	.....	B9	8.25	5	
67 98.....	1 4.0	67 15	6.65	Go	7.07	8	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
63° 147.....	1 ^h 4 ^m 0	63° 39'	A3	7.38	4	S Var.?
63 149.....	1 5.0	63 40	5.46	B9	5.62	4	
64 127.....	1 5.1	64 29	5.49	B8	5.67	5	
73 59.....	1 6.1	73 23	7.72	G0	8.39	6	
63 156.....	1 6.1	64.05	.....	A0	7.76	5
64 129.....	1 6.2	64 28	7.46	F0	7.62	6	S
61 223.....	1 6.2	61 21	.....	B	8.49	4
62 224.....	1 6.8	62 18	.....	K0	8.32	3
60 186.....	1 6.8	61 10	6.29	B9	6.46	4	
71 59.....	1 7.0	71 58	8.62	A0	8.57	8	
60 188.....	1 7.7	60 21	7.26	B3	7.06	4	
70 87.....	1 7.8	70 33	7.89	K0	8.51	7	
68 83.....	1 8.3	69 05	.....	A0	8.37	5
61 229.....	1 8.4	62 10	.....	A0	8.25	3
60 193.....	1 8.4	60 24	7.46	F5	7.78	4	
70 88.....	1 8.7	70 34	A0	8.27	8	
60 194.....	1 8.8	60 20	8.66	A	8.68	4	
70 90.....	1 9.0	71 13	6.38	K0	7.95	11	
63 164.....	1 9.2	63 47	.....	A0	8.61	5
65 145.....	1 9.5	65 36	.....	F5	8.50	4
61 233.....	1 9.6	61 22	7.36	F5	7.61	4	S
72 67.....	1 11.0	72 52	.....	A0	8.08	8
72 68.....	1 11.3	72 21	7.18	G5	8.15	8	
71 64.....	1 11.4	71 52	7.08	G5	8.18	10	
67 108.....	1 11.5	67 17	6.70	A0	6.74	8	
62 235.....	1 11.8	63 00	A0	8.33	3	S
65 151.....	1 12.2	65 37	.....	A0	8.39	5
71 67.....	1 12.3	72 13	8.44	F5	8.64	4	
66 105.....	1 13.6	66 42	.....	A3	8.45	7
73 66.....	1 13.8	74 03	7.22	A2	7.55	8	
68 93.....	1 14.1	68 29	A0	8.43	5	S
60 209.....	1 14.4	60 25	7.66	A0	7.52	4	
67 116.....	1 15.7	68 02	.....	F0	8.00	4
72 69.....	1 16.6	72 20	.....	G5	7.64	9
60 221.....	1 16.8	61 12	.....	A0	8.37	3
73 71.....	1 17.6	73 36	A0	7.95	7	S
70 102.....	1 18.4	70 28	6.52	A0	6.46	9	
69 96.....	1 19.4	69 52	.....	G0	8.35	4
66 115.....	1 19.9	67 14	.....	F5	8.59	4
63 186.....	1 20.4	64 11	.....	A3	8.23	5
73 75.....	1 21.0	73 41	7.32	G5	7.83	8	
70 105.....	1 21.9	70 24	8.39	A5	8.40	6	
64 168.....	1 22.9	64 39	6.94	K2	8.07	5	
70 107.....	1 23.1	71 12	.....	A2	9.05	2
72 75.....	1 23.2	72 22	8.15	K0	9.35	2	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
70° 108.....	1 ^h 23 ^m 5	70° 36'	.....	Ko	9.50	2	
63 193.....	1 23.5	63 21	.....	Ao	7.96	3	
69 100.....	1 23.6	70 04	8.79	Ao	8.51	2	
69 102.....	1 23.8	69 75	5.95	F5	6.37	6	
65 175.....	1 23.9	65 35	6.16	Ao	6.38	5	S
61 281.....	1 24.1	61 24	.....	B8	8.10	3	
72 76.....	1 24.5	72 24	8.34	Go	8.87	2	
62 259.....	1 24.6	62 51	7.46	Bop	7.77	3	P.D.M. = 7.60
60 253.....	1 24.9	61 02	7.56	Ao	7.75	3	S
60 255.....	1 25.0	60 32	7.96	B9	7.94	3	
73 78.....	1 25.2	64 06	.....	Ao	8.65	3	
69 103.....	1 25.2	69 30	6.93	B9	6.80	7	S
67 133.....	1 25.2	67 53	6.97	Ko	7.93	6	
67 134.....	1 25.4	67 27	.....	B9	7.92	6	
66 123.....	1 25.5	66 44	.....	A3	8.54	3	
62 263.....	1 25.5	63 05	7.71	Ao	7.85	3	
70 112.....	1 25.7	71 02	.....	F8	8.62	5	
59 271.....	1 26.6	60 10	7.26	B3	7.11	3	
61 289.....	1 26.8	62 01	.....	K2	8.10	3	
67 135.....	1 26.9	68 10	.....	Ko	8.53	4	
67 137.....	1 27.1	67 57	.....	Fo	8.20	7	
61 291.....	1 27.2	61 38	.....	Ao	8.04	3	
68 113.....	1 27.4	68 26	6.66	G5	7.13	7	
71 87.....	1 27.8	71 54	.....	G5	7.54	9	
62 274.....	1 28.6	62 34	6.79	Ko	7.71	3	
63 206.....	1 28.8	63 38	.....	A2	8.38	3	
71 89.....	1 28.9	71 27	.....	F8	9.23	2	
65 182.....	1 29.1	65 43	8.30	B9	8.23	4	
73 81.....	1 29.2	73 47	6.42	B8	6.70	7	S
66 134.....	1 29.2	67 06	7.02	Ao	7.11	8	S
64 196.....	1 29.4	64 46	.....	A2	8.52	2	
62 277.....	1 29.9	62 53	7.56	Ao	7.57	3	S
72 86.....	1 30.5	72 32	5.50	Ko	6.49	8	
71 91.....	1 30.5	72 04	.....	G5	9.14	2	
64 202.....	1 30.8	64 14	6.68	F5p	7.38	5	
73 84.....	1 31.0	74 02	7.80	Ao	8.13	5	
64 203.....	1 31.0	65 02	.....	Ko	8.29	4	
61 304.....	1 31.4	61 51	6.61	B8	6.71	4	S
74 73.....	1 31.7	75 03	.....	Fo	9.34	2	
60 290.....	1 32.4	60 34	7.11	Go	7.77	4	
71 93.....	1 33.5	71 44	.....	Ao	8.99	2	
63 218.....	1 33.9	63 40	.....	B	8.18	5	
66 145.....	1 34.1	66 25	7.60	G5	8.14	6	
65 193.....	1 34.2	65 58	8.16	A3	8.24	5	S
68 122.....	1 34.6	68 34	.....	F5	7.81	7	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
67° 149.....	1 ^h 34 ^m 9	67° 32'	5.54	Aop	5.77	8	S
66 149.....	1 34.9	66 17	7.06	Ko	7.80	5	
60 305.....	1 34.9	60 35	.....	B9	8.37	3	
69 113.....	1 35.0	69 40	.....	F8	8.12	7	
69 114.....	1 35.2	70 07	5.26	Ao	5.36	7	
73 92.....	1 35.3	74 06	6.79	G5	7.70	5	
60 308.....	1 35.3	60 32	6.63	B8	6.46	4	S
59 306.....	1 35.9	60 03	7.36	K2	8.15	3	
60 312.....	1 36.1	60 55	6.46	B8	6.24	4	S
70 124.....	1 36.4	70 24	.....	Ao	8.42	3	
59 307.....	1 36.6	60 03	5.75	B9	5.73	3	S
66 152.....	1 36.8	67 04	.....	G5	8.47	3	
74 78.....	1 37.5	74 19	.....	F5	8.47	5	
68 125.....	1 37.5	69 00	7.28	G5	8.12	8	
63 230.....	1 37.7	63 50	.....	A2	8.43	4	
71 104.....	1 38.3	71 45	.....	Go	8.95	5	
67 157.....	1 40.0	67 15	.....	F8	8.43	4	
66 156.....	1 40.6	66 43	.....	Fo	8.32	6	
62 306.....	1 40.8	63 05	.....	A3	8.26	5	
70 133.....	1 40.9	71 05	.....	Ao	8.60	4	
66 161.....	1 42.2	67 11	.....	F5	8.29	6	
74 84.....	1 42.8	75 06	6.92	F5	7.53	4	
67 164.....	1 44.0	67 52	.....	A5	7.71	7	
70 137.....	1 44.2	70 15	7.74	F8	8.05	10	
67 165.....	1 45.5	67 42	.....	A2	8.18	6	
75 76.....	1 46.2	75 44	7.02	A5	7.39	4	S
68 134.....	1 46.5	68 42	.....	Ma	8.50	2	
75 77.....	1 46.6	75 32	8.37	F5	8.54	2	
67 168.....	1 46.7	67 40	7.56	Ao	7.17	7	S
62 322.....	1 48.3	63 10	.....	A2	8.21	3	
74 87.....	1 48.7	74 51	6.70	G5	7.71	4	
61 352.....	1 48.8	61 53	.....	Ao	7.61	2	
71 111.....	1 48.9	71 14	7.14	A2	7.24	10	S
60 383.....	1 49.4	60 47	7.34	Ao	7.54	2	S
70 146.....	1 49.8	70 21	8.74	Ao	8.25	3	
64 268.....	1 50.2	64 55	7.95	B3	7.99	4	
72 112.....	1 50.3	72 40	7.10	G5	8.18	10	
73 104.....	1 50.8	73 29	.....	Fo	8.48	3	
66 171.....	1 51.0	67 65	.....	Ao	7.70	5	
66 173.....	1 51.3	66 44	.....	A2	8.42	4	
60 398.....	1 51.5	61 12	6.05	B8	5.86	3	
66 175.....	1 51.6	66 33	7.35	A3	7.37	5	S
63 265.....	1 52.2	64 08	5.18	Ao	5.56	3	S P.D.M. = 5.59
72 114.....	1 52.3	72 55	.....	G5	8.52	2	
70 153.....	1 53.7	70 25	4.61	A3	5.00	4	S

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
59° 380.....	1 ^h 54 ^m 3	60° 01'	Fo	7.48	3	S
73 108.....	1 54.4	73 22	6.24	A3	6.44	8	
63 273.....	1 54.9	64 09	.....	Fo	8.56	2
64 282.....	1 55.4	64 25	5.92	A2	6.14	4	
63 274.....	1 55.6	63 54	5.62	B5p	6.08	3	S P.D.M. = 5.82
75 86.....	1 55.9	75 38	5.30	G5	6.69	3	S
70 157.....	1 56.0	70 44	7.64	Fo	7.87	7	
73 112.....	1 56.9	74 06	7.50	Ao	7.64	7	
64 285.....	1 57.1	64 37	6.48	Ao	6.52	4	
67 181.....	1 57.4	68 07	A2	8.04	6	S
63 281.....	1 57.6	63 54	.....	B3	7.24	3
74 95.....	1 57.9	74 24	7.64	A2	7.67	7	
63 287.....	1 58.1	63 49	.....	B	8.16	3
62 344.....	1 58.1	62 28	F8	8.57	2	S
62 345.....	1 58.6	62 42	.....	Ko	8.30	3
63 296.....	1 58.9	64 06	.....	Ao	8.04	4
66 183.....	1 59.2	67 09	.....	Ao	8.62	2
70 163.....	2 0.4	71 05	6.74	F8	7.02	10	S
62 349.....	2 0.6	62 41	.....	Ao	8.11	3
64 295.....	2 1.1	64 33	7.54	B3	7.50	4	
62 357.....	2 3.2	63 07	.....	Ao	8.16	3
73 121.....	2 4.1	73 33	6.19	G5	7.23	8	S
68 153.....	2 5.1	68 54	7.95	Ao	8.12	7	
64 307.....	2 6.2	64 23	7.40	A2	7.46	5	
67 189.....	2 6.4	67 39	.....	Fo	8.20	7
66 191.....	2 6.4	66 16	Ko	8.47	4	S
65 242.....	2 7.1	65 51	7.35	F5	7.41	5	
64 309.....	2 7.3	64 33	8.14	F8	8.56	2	
63 310.....	2 7.6	63 34	.....	B5p	7.98	4
72 121.....	2 8.4	72 52	Ao	8.11	8	S
64 312.....	2 9.2	64 30	8.40	Go	8.04	4	
64 313.....	2 9.7	64 48	7.65	F8	7.97	4	
64 314.....	2 10.4	65 08	7.60	F8	7.87	4	
63 315.....	2 11.1	63 58	7.05	B5p	7.60	4	S
63 316.....	2 11.3	63 29	7.60	A3	7.68	4	
63 320.....	2 12.5	63 52	6.49	Ao	6.57	4	
63 322.....	2 12.9	63 25	.....	Ko	8.62	3
65 248.....	2 13.1	65 20	8.25	A2	8.07	4	S
73 131.....	2 14.3	73 21	.....	F5	8.20	8
69 144.....	2 14.3	69 52	.....	F5	8.25	9
68 166.....	2 14.5	68 19	7.40	G5	8.38	7	
75 94.....	2 14.6	75 41	7.57	Ao	7.67	3	S
64 321.....	2 14.6	64 47	7.25	F8	7.59	4	
62 383.....	2 14.9	62 31	.....	A3	7.55	4
72 128.....	2 15.3	73 03	8.04	Ao	8.20	8	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
63° 330.....	2 ^h 17 ^m 4	64° 07'	Ao	8.45	4	S
60 472.....	2 18.2	61 04	7.11	B8	7.00	2	
73 139.....	2 18.4	73 16	7.22	Fo	7.58	8	
71 140.....	2 18.8	71 41	7.67	B8	7.70	10	
64 327.....	2 20.0	65 01	Ao	8.57	3	S P.D.M. = 7.78
73 142.....	2 20.6	74 11	.....	Go	8.05	2
62 402.....	2 20.9	62 44	7.41	Ao	7.77	4	
66 214.....	2 21.3	66 58	.....	Ao	8.29	9
70 181.....	2 23.2	71 10	.....	Ao	8.43	2
69 155.....	2 23.3	69 50	.....	F8	8.47	6
69 157.....	2 23.5	69 41	.....	F5	8.29	9
69 158.....	2 24.3	69 46	.....	Fo	8.28	7
70 182.....	2 24.4	70 30	B3	7.64	10	S
61 422.....	2 24.8	61 22	.....	Ao	7.66	2
70 183.....	2 24.9	70 51	6.73	Ko	7.70	11	
60 502.....	2 25.1	61 01	7.82	B	7.68	2	
69 160.....	2 25.6	69 24	Ao	8.53	4	S
66 219.....	2 25.9	66 59	.....	Ao	7.81	9
70 189.....	2 26.1	70 12	8.19	Fo	8.39	7	
64 333.....	2 26.6	64 21	.....	B8	8.50	4
65 272.....	2 27.0	65 37	7.10	Ko	7.82	5	S
67 215.....	2 27.2	67 55	6.77	F2	6.95	10	
62 420.....	2 27.7	62 48	7.37	Go	8.27	3	
74 111.....	2 27.8	75 06	7.77	A3	8.18	4	
66 223.....	2 27.9	67 02	7.37	F2	7.42	9	S
72 140.....	2 28.5	72 23	5.34	Ko	6.38	9	
62 426.....	2 28.7	63 03	7.67	Ko	8.39	2	
68 176.....	2 28.8	68 38	7.42	Ko	8.31	9	
70 191.....	2 29.2	70 28	Fo	8.47	2	S
65 280.....	2 29.4	65 19	6.07	Ko	7.40	6	
63 343.....	2 29.5	63 40	7.52	F8	7.87	3	
67 217.....	2 29.8	67 38	.....	Fo	7.86	10
68 177.....	2 30.1	68 52	A2	8.02	10	S
70 197.....	2 30.7	70 48	.....	Ko	8.47	3
71 153.....	2 30.8	71 52	.....	Ao	8.45	8
61 448.....	2 32.3	62 10	7.28	Ao	7.37	3	
70 198.....	2 32.6	71 12	7.41	Ko	8.25	10	S
69 171.....	2 32.7	69 16	.....	Ao	7.44	10
67 221.....	2 33.2	68 03	.....	B8	7.37	6
67 222.....	2 33.7	67 38	.....	K2	8.27	9
61 462.....	2 34.6	61 56	7.24	Ao	7.31	2	S
60 548.....	2 34.9	61 10	6.99	Fo	7.18	3	
68 180.....	2 35.8	68 14	.....	A3	8.05	6
74 117.....	2 36.1	74 59	7.12	A3	7.44	4	
67 224.....	2 36.2	67 24	5.84	A2	6.20	9	S

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
67° 226.....	2 ^h 37 ^m 4	67° 23'	A2	8.46	5	Var.?
71 165.....	2 37.6	71 18	.....	Fo	8.33	8
65 289.....	2 37.6	65 19	.....	B8	8.22	5
71 167.....	2 39.3	71 56	8.06	G5	8.46	9	
59 541.....	2 39.5	60 09	6.68	A5	6.91	2	
71 171.....	2 40.1	71 21	G5	8.51	7	S
69 180.....	2 40.1	70 04	8.39	F2	8.48	9	
72 145.....	2 40.3	72 30	7.86	B8	7.93	12	
62 468.....	2 40.8	62 52	.....	B9	8.21	4
64 351.....	2 41.8	64 14	7.48	B9	7.53	7	
74 120.....	2 42.2	74 19.5	7.59	A2	7.69	5	S
72 146.....	2 42.9	72 52	7.29	G5	8.29	10	
59 552.....	2 43.2	60 01	7.11	Bo	7.19	2	
65 300.....	2 43.7	65 13	7.10	A2	7.22	7	
62 479.....	2 44.3	63 00	6.94	Go	7.16	4	
64 354.....	2 44.7	64 14	7.69	F2	7.92	6	S
59 559.....	2 45.2	60 03	7.36	A3	7.43	2	
74 123.....	2 45.4	74 46	7.87	F5	8.28	4	
72 149.....	2 45.4	73 58	6.82	G5	7.84	8	
72 152.....	2 46.2	72 29	7.66	Go	8.08	10	
63 367.....	2 47.0	63 43	7.78	Bp	8.10	5	S
65 306.....	2 47.6	65 24	7.55	Ao	7.44	6	
68 208.....	2 47.8	68 25	.....	B8	7.83	9
67 234.....	2 48.0	67 47	.....	Go	8.28	11
60 591.....	2 48.0	61 07	5.63	F5	5.91	2	
71 179.....	2 48.3	71 45	B9	8.32	10	S
64 356.....	2 49.6	64 40	.....	A2	8.44	6
63 370.....	2 49.7	64 01	6.92	G5	7.71	7	
67 496.....	2 49.8	62 53	7.78	Ko	8.19	2	
60 597.....	2 49.8	60 43	.....	B9	7.70	2
68 212.....	2 51.0	69 05	A2	8.00	9	S
60 608.....	2 51.9	60 53	7.00	B2	6.89	2	
62 504.....	2 52.4	62 19	.....	B	8.28	4
71 180.....	2 52.5	71 37	.....	Ao	8.52	3
72 154.....	2 52.6	72 13	.....	Ao	8.48	6
74 131.....	2 53.3	74 45	7.02	B9	7.11	5	S
70 219.....	2 54.2	70 16	8.44	Ao	8.31	5	
73 165.....	2 54.8	73 33	7.49	Ao	7.49	8	
61 513.....	2 55.9	61 21	6.67	Go	7.31	2	
70 220.....	2 56.2	70 38	.....	Go	8.41	4
64 365.....	2 56.6	65 09	8.15	F8	8.40	6	S
70 225.....	2 56.9	71 08	.....	Ao	8.41	6
62 512.....	2 57.1	62 38	7.42	B8	7.44	5	
64 366.....	2 57.2	64 46	7.27	Ko	8.30	7	
64 367.....	2 57.5	65 03	8.05	A5	8.01	7	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
66° 242.....	2 ^h 57 ^m 9	67° 01'	.....	Go	8.41	6	
69 196.....	2 58.1	69 51	8.24	A5	8.31	6	
62 516.....	2 58.3	62 25	.....	Ao	8.38	2	
72 156.....	2 58.6	72 26	.....	Ao	8.56	2	
63 390.....	2 58.9	63 41	5.82	B9	5.87	5	S
69 199.....	2 59.9	69 24	.....	Ao	8.22	7	
61 525.....	3 0.7	62 00	6.54	Bo	6.68	2	
63 395.....	3 0.9	63 55	6.87	G5	7.81	4	
67 240.....	3 1.0	67 59	.....	A2	8.19	9	
73 168.....	3 1.1	74 01	4.89	A2	4.55	4	S
73 169.....	3 1.8	73 49	.....	Fo	7.93	8	
65 325.....	3 2.4	65 30	.....	Ao	8.37	5	
64 375.....	3 2.5	64 31	6.52	A5	6.66	7	S
63 298.....	3 2.5	63 25	7.38	F8	7.74	4	
73 170.....	3 2.6	73 55	7.46	F8	7.76	8	
70 230.....	3 2.7	71 11	7.68	F8	8.07	11	
64 376.....	3 3.5	64 43	.....	Fo	7.57	7	
60 636.....	3 3.5	60 15	7.26	Ao	7.44	2	S P.D.M. = 7.49
65 326.....	3 3.8	65 31	.....	A2	8.24	5	
61 535.....	3 4.1	62 11	.....	Ao	8.09	3	
73 172.....	3 4.4	73 30	6.80	Ko	8.18	9	
67 250.....	3 4.6	68 10	7.72	G5	8.44	6	
63 402.....	3 4.9	63 13	.....	B9	8.47	2	
61 540.....	3 6.4	61 21	.....	Ao	7.83	2	
63 403.....	3 6.5	63 35	.....	B8	8.41	2	
69 302.....	3 7.0	69 37	.....	Ao	7.48	10	
64 378.....	3 7.1	64 33	.....	F8	8.37	5	
60 651.....	3 7.5	60 45	.....	B8	7.51	2	
72 166.....	3 7.8	72 25	.....	F2	8.37	5	
68 230.....	3 7.9	69 04	.....	Ao	7.83	10	
74 144.....	3 8.6	74 52	7.47	B9	7.32	4	S
65 338.....	3 8.8	65 17	6.35	A2	6.42	8	S
73 179.....	3 10.3	73 20	7.10	Ko	8.06	8	
69 203.....	3 10.5	69 22	6.68	Ao	6.50	10	S
66 253.....	3 10.5	66 51	.....	F8	8.25	11	
67 256.....	3 11.5	68 06	7.58	Ko	7.06	9	
67 257.....	3 11.7	67 24	.....	F5	7.89	9	
73 180.....	3 12.9	73 49	6.94	F8	7.18	7	
70 241.....	3 12.9	70 55	7.53	Fo	7.59	11	
61 559.....	3 13.1	61 38	6.65	B8	6.52	3	S
70 242.....	3 13.5	71 03	7.73	B8	8.12	11	
72 172.....	3 15.1	72 51	7.30	Ko	8.31	6	
71 197.....	3 15.1	71 20	.....	B8	7.47	11	
64 391.....	3 16.0	64 14	5.55	Mo	7.35	5	
71 198.....	3 16.3	71 51	7.18	Fo	7.09	9	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
68° 242.....	3 ^h 16 ^m 3	68° 48'	.....	F8	8.30	3	
65 345.....	3 17.9	65 51	7.28	Ko	8.34	4	
62 566.....	3 18.1	62 50	7.32	Go	8.18	4	
72 173.....	3 18.4	72 14	.....	A3	8.40	4	
74 151.....	3 18.5	74 54	7.92	Ao	7.97	5	
59 655.....	3 18.7	60 03	7.66	A2	7.61	3	S
68 249.....	3 19.3	68 56	7.52	F5	7.51	8	
68 250.....	3 19.7	69 07	7.68	Ao	7.56	10	S
71 201.....	3 19.9	71 31	6.83	Ma	8.10	10	
67 270.....	3 20.8	68 06	.....	B8	7.60	6	
71 202.....	3 21.0	71 50	.....	Ao	8.15	10	
71 203.....	3 21.0	71 40	.....	Ao	8.04	11	
71 204.....	3 21.0	71 31	.....	Ao	7.77	11	
72 178.....	3 24.2	73 01	6.41	Ao	6.55	8	S
65 348.....	3 24.5	65 12	7.04	A2	7.13	6	S
74 158.....	3 25.3	74 18	.....	F8	8.21	3	
68 258.....	3 25.6	68 27	.....	A2	8.43	2	
63 426.....	3 25.9	63 34	7.68	B3	7.89	3	
74 161.....	3 27.0	74 24	7.60	Ko	8.32	4	
67 277.....	3 27.0	67 38	.....	F8	8.29	8	
63 430.....	3 27.1	63 55	.....	B8	8.05	4	
73 190.....	3 27.6	74 08	.....	A2	8.39	2	
64 398.....	3 28.2	65 01	8.00	F8	8.32	6	
62 584.....	3 28.7	62 37	7.84	Ao	8.59	4	
65 353.....	3 30.0	65 19	7.40	Ao	7.42	5	
63 436.....	3 31.0	63 58	7.30	F8	7.81	4	
66 279.....	3 31.3	66 38	.....	Fo	8.48	2	
72 184.....	3 32.0	73 05	.....	F8	8.45	2	
69 222.....	3 32.6	69 32	7.13	A3	7.07	8	S
65 357.....	3 32.7	65 48	.....	A2	7.74	5	
74 168.....	3 33.5	74 13	6.82	G5	7.64	8	
62 597.....	3 33.5	62 54	5.32	Ma	6.78	5	
72 187.....	3 34.9	72 43	.....	Go	8.37	4	
71 216.....	3 35.7	71 18	7.08	G5	7.75	10	
66 284.....	3 36.5	66 53	5.84	F2	6.10	7	
60 735.....	3 36.5	61 09	7.52	A2	7.71	3	S
69 225.....	3 37.4	69 54	8.49	Fo	8.28	5	
70 257.....	3 38.8	70 34	5.56	Ao	5.57	9	S
70 259.....	3 39.8	71 02	4.67	Ao	4.98	3	
64 408.....	3 39.9	64 27	.....	F5	7.68	5	
66 290.....	3 40.2	66 51	.....	G5	8.01	7	
65 369.....	3 40.4	65 13	4.71	Ma	6.33	5	
62 612.....	3 40.8	63 00	5.96	A3	5.93	4	S
68 283.....	3 41.0	68 48	7.21	Ko	7.89	7	
70 262.....	3 41.4	70 12	7.39	A3	7.35	8	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
72° 192.....	3 ^h 41 ^m 55 ^s	72° 54'	.....	Ao	8.15	8	S
68 286.....	3 41.8	68 12	6.33	B8	6.17	9	
67 296.....	3 43.0	67 16	.....	Fo	7.48	8	S
61 644.....	3 43.7	62 02	6.82	A2	6.60	3	
63 458.....	3 44.3	63 11	8.10	B5	7.76	3	
64 412.....	3 44.6	64 26	.....	F8	7.91	5	
73 204.....	3 44.9	73 47	6.99	Ko	8.21	8	
71 222.....	3 45.8	71 32	6.39	Fo	6.52	9	
72 199.....	3 46.9	72 26	6.75	Ko	7.78	10	
69 231.....	3 46.9	69 14	.....	G5	8.38	3	
62 628.....	3 48.6	62 47	4.87	B0	5.39	3	S P.D.M. = 5.20
60 768.....	3 48.6	60 49	5.22	K4	6.42	4	
67 299.....	3 48.7	68 05	.....	Fo	7.88	7	
67 300.....	3 48.9	67 44	7.36	G5	8.14	9	
62 629.....	3 48.9	62 29	.....	F2	7.91	3	
65 381.....	3 49.4	65 17	7.90	Ao	7.79	7	
66 301.....	3 51.6	66 46	.....	A2	8.35	4	S
62 643.....	3 54.1	62 09	7.28	B5	7.14	3	
74 184.....	3 54.9	74 55	7.32	F8	7.56	5	
74 186.....	3 55.3	74 22	6.86	Ko	7.53	6	
73 210.....	3 55.4	73 43	6.72	Ko	7.42	9	
68 303.....	3 55.9	68 24	6.14	K2	7.45	9	
61 665.....	3 56.1	62 03	7.68	F5	7.16	2	
70 274.....	3 56.3	70 11	8.59	B9	8.18	3	
65 391.....	3 57.3	65 14	6.07	A2	6.20	7	S
64 424.....	3 57.3	64 45	.....	A3	7.96	6	
61 669.....	3 57.4	61 48	6.75	B2	6.60	2	
69 235.....	3 57.5	69 36	.....	Ao	8.29	7	
73 212.....	3 57.7	73 18	6.88	F5	7.12	9	
70 276.....	3 58.2	71 04	7.49	B9	7.42	9	S
74 188.....	3 58.7	74 24	.....	A3	8.47	2	
61 673.....	3 58.7	62 08	.....	Ao	7.67	2	
69 238.....	3 59.3	69 17	.....	G5	8.36	6	
60 780.....	3 59.8	60 37	7.46	B9	7.28	4	
67 310.....	4 0.0	68 07	7.32	Fo	7.34	7	
69 240.....	4 0.1	70 05	8.09	G5	8.40	4	
71 239.....	4 2.6	71 52	6.15	G5	7.01	9	
68 310.....	4 2.8	68 16	6.41	Ko	7.45	7	
67 312.....	4 2.9	68 05	.....	A2	8.34	2	
70 281.....	4 3.8	70 57	.....	.....	7.83	12	
72 198.....	4 3.9	72 47	.....	A2	8.29	6	
69 243.....	4 4.0	69 16	7.27	Ko	8.42	5	
70 286.....	4 6.4	70 12	7.79	K2	8.26	3	
74 194.....	4 6.5	74 23	.....	K2	7.26	5	
66 316.....	4 8.1	66 51	6.94	B8	6.60	7	S

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
61° 687.....	4 ^h 8 ^m 1	61° 36'	5.64	B8	5.54	2	S
67 319.....	4 9.9	67 38	.....	F8	8.37	4	
63 491.....	4 10.0	63 43	.....	F0	7.80	4	
60 792.....	4 10.0	60 14	7.41	B9	7.48	3	S
61 694.....	4 10.4	61 22	.....	A3	7.81	4	
64 433.....	4 11.2	64 54	5.40	G0	6.06	6	
70 293.....	4 11.7	70 48	.....	A0	8.45	4	
66 318.....	4 12.6	67 03	.....	F0	8.24	3	
60 799.....	4 12.9	60 33	.....	B9	7.76	4	
60 800.....	4 13.1	60 30	5.67	K0	7.00	4	
68 320.....	4 13.4	68 53	.....	G5	8.43	5	
67 325.....	4 14.2	67 41	.....	F2	8.02	7	
71 250.....	4 15.8	71 33	7.52	B8	7.54	9	S
67 327.....	4 16.4	67 49	.....	B9	7.98	6	
71 254.....	4 17.8	71 27	.....	F0	8.34	8	
67 329.....	4 18.1	67 28	.....	F2	8.05	7	
69 258.....	4 19.4	69 09	7.02	K0	8.24	9	
72 224.....	4 20.3	73 02	.....	G0	8.43	2	
68 329.....	4 20.3	69 02	.....	A0	8.36	7	
62 683.....	4 20.9	62 29	.....	A3	7.76	2	
64 449.....	4 21.1	64 50	.....	F0	7.89	4	
72 227.....	4 21.9	72 19	5.97	A5	6.14	9	S
69 261.....	4 23.0	69 23	.....	G5	8.41	5	
67 334.....	4 23.1	67 25	6.86	A2	6.93	5	S
72 228.....	4 23.4	72 44	.....	K0	8.29	2	
68 334.....	4 23.6	68 58	.....	A2	8.40	3	
64 457.....	4 23.7	64 46	7.40	F5	7.78	5	
70 305.....	4 23.8	70 08	.....	.....	7.72	4	
63 511.....	4 24.0	63 57	7.03	G5	8.35	3	
61 718.....	4 25.2	61 40	.....	A3	8.34	3	
73 237.....	4 25.6	23 56	.....	F0	8.40	3	
71 263.....	4 26.4	71 41	.....	A2	7.84	9	
67 339.....	4 27.1	68 05	7.37	B8	7.21	5	S
63 515.....	4 27.1	64 03	5.91	A0	5.88	2	S
61 720.....	4 27.5	61 10	7.22	K2	8.17	3	
72 230.....	4 27.6	72 22	.....	F5	8.44	3	
66 335.....	4 29.1	67 01	.....	A0	7.68	5	
60 825.....	4 29.1	60 28	7.86	G5	8.31	3	
68 340.....	4 29.4	68 55	.....	A0	7.86	7	
60 826.....	4 29.4	60 41	6.77	K0	8.26	3	
62 395.....	4 30.3	63 01	.....	A2	7.63	2	
64 469.....	4 30.8	64 21	.....	G5	7.94	3	
72 233.....	4 30.9	72 47	.....	F0	8.26	5	
69 267.....	4 31.8	69 45	.....	B9	8.17	8	
67 343.....	4 33.4	67 57	.....	A0	7.75	5	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
75° 189.....	4 ^h 35 ^m .4	75° 46'	6.04	Fo	6.17	3	
72 236.....	4 35.6	72 58	.....	A2	8.33	2	
67 347.....	4 38.1	67 35	6.97	Fo	7.15	5	
63 536.....	4 40.8	63 27	6.72	Ao	6.68	2	S
72 242.....	4 42.1	72 53	.....	F5	8.35	3	
63 543.....	4 42.7	63 20	5.81	Ma	7.15	2	
67 353.....	4 43.4	68 03	7.42	Ko	8.17	5	
67 354.....	4 43.6	67 20	7.49	F2	7.74	5	
65 435.....	4 43.6	65 49	7.57	G5	7.94	4	
61 739.....	4 44.7	61 19	6.63	A3	6.65	2	S
66 362.....	4 45.4	66 46	.....	B9	8.00	6	
67 357.....	4 47.3	67 38	7.14	B8	7.13	6	S
65 439.....	4 47.7	65 08	6.78	G5	7.80	4	
71 282.....	4 47.9	71 28	.....	Ao	7.89	7	
61 742.....	4 48.2	61 36	6.90	Go	7.75	2	
67 360.....	4 48.3	67 16	.....	F8	8.26	4	
69 288.....	4 49.2	69 47	7.84	Ao	7.77	5	
74 229.....	4 49.6	74 07	6.23	Ko	7.78	4	
68 357.....	4 51.3	69 02	7.07	F5	7.30	4	
73 365.....	4 52.0	73 55	6.00	A2	6.02	4	S
60 853.....	4 52.6	60 58	6.12	F5	6.47	5	
66 370.....	4 52.7	66 41	6.29	F8	6.46	3	
68 361.....	4 55.4	68 50	6.80	F2	6.86	4	
60 857.....	4 57.5	61 02	6.27	Ko	7.61	5	
69 301.....	4 58.3	69 43	.....	B9	7.95	4	
69 302.....	4 58.7	69 30	6.58	Ko	7.41	4	
73 274.....	4 59.7	73 49	5.38	Aop	5.27	4	S
64 500.....	5 0.1	64 47	6.40	F2	6.61	5	
72 258.....	5 0.4	72 37	.....	B8	7.36	5	
62 730.....	5 0.5	62 21	6.74	A5	6.79	3	S
63 566.....	5 1.3	63 27	6.66	Fo	6.88	4	
65 459.....	5 1.8	65 53	.....	Ao	8.27	2	
67 367.....	5 2.1	67 33	7.28	F2	7.52	4	
64 503.....	5 2.9	64 10	.....	F8	8.17	4	
64 504.....	5 3.2	64 37	.....	F5	8.32	3	
69 307.....	5 3.3	69 42	7.24	Ko	7.99	2	
67 371.....	5 3.7	67 21	7.12	Ao	7.09	2	S
61 766.....	5 3.9	61 44	5.99	Ao	6.20	4	S P.D.M.=6.36
65 464.....	5 4.0	65 56	7.88	F2	7.91	2	
62 734.....	5 4.2	62 34	6.38	A2	6.83	3	S
67 373.....	5 4.4	67 15	7.58	Fo	7.72	3	
74 238.....	5 4.6	74 25	7.25	A2	7.47	2	S
62 735.....	5 5.2	62 59	6.74	Fo	7.07	3	
73 280.....	5 5.9	73 09	5.76	Ao	5.77	4	S
71 299.....	5 8.9	71 36	6.76	G5	7.59	4	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
67° 379.....	5 ^h 9 ^m 2	67° 53'	7.38	A2	7.50	3	S
66 385.....	5 10.5	66 38	6.59	G5	7.21	4	
62 742.....	5 11.0	62 33	5.88	K4	7.42	3	
66 387.....	5 11.6	66 55	.....	Ko	8.19	4	
73 285.....	5 12.4	73 36	7.03	Ma	8.26	3	
69 317.....	5 12.5	69 28	.....	A5	8.20	4	
66 391.....	5 12.7	66 06	.....	Ao	8.06	2	
63 577.....	5 14.0	64 02	.....	F8	7.71	3	
73 289.....	5 14.5	73 25	.....	Ao	8.10	4	
74 241.....	5 14.6	74 28	7.18	Aop	7.30	3	S
64 523.....	5 15.0	64 38	7.65	F8	8.15	3	
63 579.....	5 15.3	63 17	7.27	Go	7.84	3	
74 242.....	5 15.6	74 13	6.94	B9	6.86	3	S
70 351.....	5 15.6	70 08	7.04	B9	7.02	3	S
61 783.....	5 15.8	61 44	.....	B9	7.88	3	
67 384.....	5 17.7	67 34	.....	A2	8.15	3	
67 385.....	5 18.3	67 50	.....	B8	8.09	4	
67 386.....	5 20.0	67 08	.....	A3	8.36	3	
63 585.....	5 20.9	63 52	.....	F8	8.26	3	
60 884.....	5 20.9	60 11	6.85	Ao	6.87	3	S
64 532.....	5 21.9	64 15	.....	Go	8.04	3	
62 762.....	5 22.3	62 55	7.46	Ao	7.45	3	S
67 390.....	5 22.6	67 56	6.92	Fo	6.92	3	
69 327.....	5 23.0	69 35	7.94	F5	8.22	3	
74 249.....	5 23.9	74 15	6.99	Fo	7.16	2	
74 250.....	5 24.4	74 38	7.47	Go	8.02	2	
70 360.....	5 25.0	71 00	.....	Ao	8.24	4	
64 533.....	5 25.0	65 00	8.55	Ao	8.31	5	
64 534.....	5 25.0	64 58	7.50	A2	7.17	5	
68 393.....	5 25.6	69 02	.....	F5	8.20	3	
71 313.....	5 26.1	71 35	6.82	G5	7.48	5	
74 252.....	5 26.3	74 59	6.36	K5	7.81	2	
63 592.....	5 26.5	63 25	.....	A3	7.79	4	
66 401.....	5 27.0	66 38	6.24	A5	6.34	4	S
70 362.....	5 27.5	70 18	6.85	Ao	6.83	3	S
64 482.....	5 27.6	65 03	7.80	A2	7.83	5	
64 536.....	5 27.6	64 06	6.03	B9	6.11	4	S
72 281.....	5 27.9	72 08	.....	A2	7.85	4	
60 890.....	5 28.1	60 32	.....	Ao	8.17	3	
69 339.....	5 29.0	69 55	7.04	Ko	7.73	3	
73 298.....	5 30.2	73 56	6.79	Fo	6.94	3	
71 314.....	5 30.3	71 35	.....	A2	7.96	5	
61 806.....	5 31.2	61 53	6.65	A5	6.93	4	S
62 775.....	5 32.2	62 34	.....	A5	8.16	3	
63 599.....	5 32.3	63 14	7.18	G5	8.05	6	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
65° 485.....	5 ^h 32 ^m 4	65° 38'	5.78	Ko	6.82	3	S
60 894.....	5 32.6	60 34	6.98	A3	7.08	5	
74 257.....	5 33.2	74 34	7.27	Go	7.80	2	
66 405.....	5 33.4	66 28	.....	A2	8.24	3
61 813.....	5 33.4	61 35	.....	F5	8.14	4
68 401.....	5 33.6	68 49	.....	F5	8.12	3
71 319.....	5 34.2	71 53	.....	Fo	8.08	4
67 396.....	5 34.3	67 55	.....	Fo	7.96	5
67 397.....	5 34.3	67 15	.....	Fo	8.18	5
60 897.....	5 34.5	60 58	.....	F5	7.90	5
62 779.....	5 34.6	62 19	F5	8.34	3	S P.D.M.=6.48
61 816.....	5 34.9	61 26	6.39	G5	7.07	5	
64 544.....	5 36.4	64 43	6.86	Ko	8.12	4	
63 602.....	5 36.4	63 15	7.57	Fo	8.10	6	
63 604.....	5 37.9	63 34	6.62	G5	7.58	6	
62 784.....	5 39.6	62 46	6.13	A2	6.38	3	
72 288.....	5 40.2	72 27	.....	F8	8.03	3
71 324.....	5 40.6	71 15	7.17	A3	7.17	4	
65 497.....	5 41.0	64 44	6.65	F8	7.21	2	
68 412.....	5 42.2	68 26	6.40	F5	8.12	3	
61 831.....	5 44.1	61 39	A2	7.64	5	S
67 405.....	5 45.0	67 32	.....	A3	8.10	3
72 299.....	5 45.5	72 38	.....	F2	7.50	3
63 616.....	5 46.6	63 16	.....	A5	7.85	3
69 350.....	5 47.0	69 35	7.04	Fo	7.24	2	
66 413.....	5 47.5	66 05	6.59	Ko	7.65	2	
60 915.....	5 49.7	60 22	7.01	Fo	7.13	4	
66 419.....	5 50.4	67 00	6.87	Ao	6.91	4	
65 507.....	5 51.3	65 31	6.74	A3	6.68	3	
67 407.....	5 52.1	67 19	.....	Ao	8.16	4
65 509.....	5 52.2	65 03	7.45	Ko	8.26	5	S
66 423.....	5 54.6	66 58	.....	F5	7.97	4
66 425.....	5 55.9	66 17	.....	Ao	7.93	4
65 510.....	5 56.1	65 09	8.25	F2	8.33	5	
64 564.....	5 56.5	64 06	.....	F5	7.96	3
65 511.....	5 57.1	65 24	7.60	A3	7.76	5	
63 330.....	5 57.1	63 27	6.49	Ko	7.48	3	
68 423.....	5 57.8	68 44	.....	Ao	8.09	3
62 811.....	5 58.7	62 59	.....	A5	8.34	2
62 813.....	5 58.9	62 37	.....	Ao	8.03	4
68 425.....	5 59.9	68 26	Fo	7.80	3	S
71 340.....	6 0.3	71 09	7.47	F5	7.76	3	
62 818.....	6 1.6	62 20	.....	B3	8.04	3
60 931.....	6 2.2	60 28	6.79	Ma	8.24	4	
65 517.....	6 2.8	65 44	5.39	Ko	6.75	3	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
70° 395.....	6 ^h 4 ^m 6	70° 49'	7.61	G5	8.05	4	S
69 368.....	6 6.0	69 30	7.56	A0	7.60	3	
60 938.....	6 6.7	60 02	5.56	K0	6.72	4	
65 519.....	6 7.1	65 44	.....	K2	8.29	3
64 575.....	6 7.4	64 52	7.55	K0	8.18	4	
69 373.....	6 8.5	69 52	6.83	A5	6.81	4	S
72 311.....	6 8.7	72 11	6.80	G5	7.88	3	
61 869.....	6 8.7	61 33	5.30	Ma	6.92	4	
68 436.....	6 8.8	68 43	6.93	G0	7.55	3	
74 281.....	6 9.7	74 54	7.87	F8	7.94	2	
71 350.....	6 9.9	71 19	A0	8.17	3	S
61 878.....	6 12.9	61 48	7.15	F0	7.41	4	
60 951.....	6 13.0	60 49	7.40	A2	7.47	4	
64 580.....	6 14.0	64 57	8.40	F5	8.46	3	
66 441.....	6 14.2	66 34	.....	F0	8.32	3
60 955.....	6 15.2	60 08	7.26	K0	8.18	4	S
70 401.....	6 16.8	70 35	5.99	A2	6.14	5	
60 961.....	6 17.0	60 51	.....	A0	8.43	4
72 317.....	6 17.8	72 05	.....	B9	7.91	6
70 402.....	6 18.8	69 59	8.44	A0	8.29	3	
60 971.....	6 21.4	60 13	6.72	B8	6.79	3	S
60 974.....	6 23.4	60 49	.....	A0	8.49	2
65 533.....	6 24.3	65 21	7.55	F2	7.97	2	
72 322.....	6 24.6	72 06	7.79	G0	8.14	5	
75 258.....	6 25.0	75 46	7.82	F8	8.06	2	
73 340.....	6 25.3	73 46	6.22	F2	6.36	3	S
70 406.....	6 25.5	70 35	7.72	A2	7.69	3	
71 358.....	6 27.5	71 14	.....	A0	8.08	5
74 393.....	6 28.2	74 08	.....	F2	8.17	3
64 593.....	6 28.5	64 49	7.45	F5	8.05	3	
61 893.....	6 28.6	61 34	6.05	G0	6.68	2	
71 359.....	6 28.7	71 50	6.07	G5	7.01	4	
66 455.....	6 29.4	66 15	7.64	B8	7.52	3	
61 896.....	6 29.4	61 34	7.02	A3	6.94	2	
61 895.....	6 29.4	61 06	.....	A0	8.31	2
67 441.....	6 29.8	67 24	B9	7.91	4	P.D.M. = 6.90
75 264.....	6 30.0	75 09	8.02	F0	8.27	2	
65 537.....	6 31.1	65 04	7.55	G5	8.38	3	
62 867.....	6 31.3	62 01	6.55	A2	6.76	3	
66 460.....	6 32.4	66 17	7.12	F8	7.57	3	
66 463.....	6 34.0	66 23	F8	8.07	2	
63 657.....	6 34.7	63 04	6.86	K2	8.14	2	
69 389.....	6 36.4	69 44	8.12	A0	8.01	4	
62 874.....	6 36.4	62 44	.....	B8	7.61	3
67 447.....	6 37.1	66 59	.....	F8	8.34	2

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
63° 658.....	6 ^h 38 ^m 1	63° 10'	.....	G5	8.41	2	
67 454.....	6 40.5	67 41	5.04	B3	5.08	3	
64 603.....	6 41.4	69 28	.....	B9	8.20	3	
63 353.....	6 42.7	73 32	.....	A2	7.98	3	
69 394.....	6 42.9	69 00	5.13	B5	5.26	3	S
67 458.....	6 43.0	67 20	.....	A2	8.26	3	
68 454.....	6 44.1	68 22	.....	F2	8.06	4	
70 427.....	6 46.3	70 13	.....	A0	8.01	4	
68 456.....	6 46.4	68 19	.....	B9	8.15	5	
68 458.....	6 48.4	68 53	7.62	F8	8.08	5	
63 672.....	6 48.6	63 09	7.48	A5	7.67	3	S
60 1015.....	6 49.2	60 55	7.62	F8	7.83	3	
70 430.....	6 50.0	70 57	5.83	K0	7.04	4	
67 466.....	6 50.0	67 28	6.54	G5	7.55	5	
69 398.....	6 50.8	69 47	6.74	G5	7.63	4	
71 378.....	6 52.0	71 54	.....	F8	7.48	4	
65 553.....	6 52.2	65 54	7.62	A0	7.82	3	S
63 378.....	6 52.5	63 49	6.71	K5	8.21	4	
67 470.....	6 53.4	67 36	.....	G0	8.31	3	
69 402.....	6 53.7	69 03	.....	F8	8.31	6	
61 928.....	6 53.8	61 27	7.72	F2	8.04	4	
70 432.....	6 54.6	70 63	6.61	K0	8.05	4	
64 616.....	6 57.0	64 35	.....	F5	8.46	3	
60 1027.....	6 57.5	60 17	.....	A2	8.16	4	
66 480.....	6 58.8	66 13	.....	A2	8.17	2	
64 618.....	6 59.2	64 31	.....	A0	8.20	4	
63 690.....	7 0.3	63 02	.....	A5	8.46	2	
72 350.....	7 0.6	72 50	7.50	A0	7.54	2	S
61 938.....	7 0.7	60 57	6.73	K0	7.63	3	
62 910.....	7 1.0	62 17	.....	K5	8.22	3	
60 1032.....	7 1.3	60 14	.....	F2	8.45	3	
63 692.....	7 1.4	63 28	.....	F5	8.16	4	
72 352.....	7 2.3	71 59	6.45	K0	7.48	2	
60 1034.....	7 2.6	60 23	7.31	K0	8.15	3	
62 913.....	7 3.3	62 26	.....	B9	7.46	3	
73 366.....	7 3.8	73 29	7.70	F8	8.03	2	
61 948.....	7 5.7	61 16	.....	F5	8.84	3	
62 916.....	7 5.8	62 19	.....	G0	8.34	2	
65 562.....	7 6.4	64 57	7.25	F8	8.00	4	
60 1039.....	7 8.3	60 06	7.86	F5p	8.26	3	
66 493.....	7 9.1	66 55	7.62	F8	8.15	4	
68 472.....	7 10.0	68 43	7.84	A5	8.18	3	S
61 959.....	7 12.9	60 08	.....	F0	8.43	4	
60 1046.....	7 13.1	60 31	.....	F5	7.80	4	
67 485.....	7 13.2	68 26	.....	G0	8.28	3	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
70° 449.....	7 ^h 13 ^m 5	70° 53'	7.92	Ao	8.00	3	S
60 1048.....	7 13.5	60 05	6.28	A5	6.63	4	S P.D.M.=6.64
74 322.....	7 13.6	74 03	7.40	Ao	7.42	3	S
64 630.....	7 14.7	64 19	7.34	A2	7.65	4	S
66 498.....	7 14.9	66 00	7.33	A5	7.81	3	
64 486.....	7 15.0	67 19	.....	Ao	7.73	4	
61 963.....	7 15.0	61 39	.....	A2	7.73	3	
74 324.....	7 16.5	74 21	.....	A5	7.94	2	
66 502.....	7 17.5	66 32	6.29	B9	6.58	4	S P.D.M.=6.78
66 503.....	7 18.1	66 42	7.52	A5	7.94	4	S P.D.M.=8.08
68 480.....	7 20.5	68 40	5.80	Ko	6.98	3	
74 327.....	7 21.7	74 33	.....	F2	8.30	2	
62 933.....	7 22.6	62 43	6.77	Ao	7.02	3	S
71 405.....	7 22.9	71 48	7.57	A3	7.78	4	S
62 934.....	7 23.1	61 58	6.75	G5	7.70	3	
73 381.....	7 26.4	73 49	7.59	F5	8.00	3	
65 579.....	7 27.0	65 19	7.35	Ko	8.27	4	
63 719.....	7 27.9	63 34	.....	F2	7.82	2	
66 514.....	7 28.7	66 26	7.07	Ko	8.21	3	
60 1069.....	7 28.8	60 44	6.86	Ao	6.94	2	S
67 499.....	7 29.1	67 16	.....	Fo	8.34	5	
61 983.....	7 29.2	61 46	7.17	F5	7.69	2	
66 517.....	7 30.2	66 30	.....	Ao	8.26	3	
67 501.....	7 31.7	67 47	.....	Go	8.45	2	
66 519.....	7 32.1	66 27	.....	A2	8.29	3	
65 586.....	7 33.3	65 31	.....	Fo	8.17	3	
65 585.....	7 33.3	65 14	.....	F5	8.38	3	
67 506.....	7 33.8	67 06	.....	A5	8.36	4	
65 591.....	7 36.3	64 56	7.85	F5	8.14	3	
65 592.....	7 36.4	65 24	6.98	F2	7.41	3	
69 438.....	7 36.6	69 24	7.19	Fo	7.31	3	
70 474.....	7 36.8	70 27	7.14	Go	7.80	4	
65 593.....	7 37.1	65 42	6.00	Ko	7.24	2	
63 733.....	7 37.4	63 04	6.35	A5	6.87	4	S
64 649.....	7 37.7	64 17	6.79	A2	6.94	5	S
60 1082.....	7 39.3	60 33	6.86	F5	7.47	3	
64 651.....	7 39.6	64 37	8.00	F2	8.17	4	
60 1084.....	7 41.5	60 34	6.70	A2	6.79	3	
64 654.....	7 42.1	64 21	.....	Ko	8.25	4	
71 429.....	7 43.4	71 20	7.17	B8	7.25	4	S
72 385.....	7 45.4	72 06	7.24	F5	7.64	3	
72 386.....	7 46.0	71 56	7.52	Ao	7.53	4	S
63 743.....	7 46.3	63 37	.....	F8	8.14	2	
62 900.....	7 46.7	62 17	7.29	G5	8.26	2	
74 338.....	7 48.2	74 11	5.56	Ko	6.94	2	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
65° 606.....	7 ^h 51 ^m 1	65° 01'	7.33	Fo	7.41	4	S
60 1105.....	7 53.2	60 36	6.00	A2p	6.16	3	
61 1021.....	7 53.6	61 16	6.70	F2	7.07	3	
65 607.....	7 53.9	65 25	7.56	F2	7.84	4	
60 1106.....	7 54.0	60 42	.....	Go	8.41	3
62 970.....	7 54.4	61 55	6.59	A0	6.60	3	S
70 497.....	7 59.9	70 00	6.55	F8	7.09	4	
68 524.....	8 2.9	68 46	5.48	G5	6.47	3	
62 983.....	8 6.2	62 20	.....	B0	8.51	2
66 541.....	8 6.3	66 29	7.02	F2	7.57	5	
60 1117.....	8 7.0	60 19	G5	8.18	2	
60 1119.....	8 7.4	60 41	6.36	Fo	6.50	2	
64 674.....	8 7.5	64 01	.....	F5	7.54	2
61 1038.....	8 9.8	61 46	.....	Go	8.56	2
63 770.....	8 9.9	63 32	.....	Go	8.14	2
60 1126.....	8 10.5	60 48	Fo	7.23	2	
62 991.....	8 10.6	62 49	5.77	Go	6.69	2	
69 404.....	8 14.0	69 14	7.16	F5	7.52	3	
61 1043.....	8 14.4	60 57	6.48	G5	7.33	3	
62 996.....	8 15.5	62 37	.....	B9	7.57	3
65 632.....	8 16.2	65 03	7.50	F5	7.80	3	
60 1132.....	8 17.7	60 02	8.66	Fo	8.65	3	
67 545.....	8 20.4	67 38	6.01	G5	6.79	4	
69 470.....	8 21.1	68 52	6.89	B0	7.12	2	
60 1136.....	8 22.9	60 15	7.06	F8	7.77	3	
69 472.....	8 23.0	69 39	6.44	Ko	7.79	4	S P.D.M. = 5.74
65 638.....	8 25.6	65 29	5.39	A0	5.58	3	
74 370.....	8 28.6	73 59	6.29	Ko	8.10	3	
65 643.....	8 30.3	65 22	.....	Go	6.23	2
60 1148.....	8 31.0	60 17	6.42	A0	6.29	3	
64 698.....	8 31.5	64 40	4.76	K2	5.98	4	S
73 428.....	8 32.0	73 31	6.93	A0	6.82	3	
61 1056.....	8 32.6	60 58	.....	Fo	8.21	3
61 1070.....	8 34.8	61 17	7.46	Ko	8.31	3	S
73 430.....	8 35.1	73 39	7.40	A2	7.26	4	
72 427.....	8 36.7	72 45	7.54	F2	7.74	5	S
66 575.....	8 38.9	66 35	.....	F8	8.05	3
67 500.....	8 39.8	67 05	6.15	B8	6.09	5	
64 707.....	8 41.1	64 38	7.20	Ko	8.46	2	
60 1078.....	8 41.7	61 36	.....	A2	7.74	2
62 1027.....	8 45.2	62 20	5.72	Fo	6.08	3	
71 482.....	8 46.0	71 11	.....	K2	8.35	4
65 673.....	8 48.1	64 59	5.62	G5	6.64	4	
66 587.....	8 48.2	65 54	7.42	G5	8.33	3	
61 1088.....	8 49.6	61 28	.....	A3	8.66	4

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
66° 589.....	8 ^h 50 ^m 0	66° 23'	7.22	Fo	7.60	6	
63 810.....	8 50.6	63 50	7.07	G5	8.18	4	
63 812.....	8 50.7	63 44	6.94	Fo	7.20	5	
62 1036.....	8 52.1	62 20	.....	Ko	8.57	4	
68 551.....	8 53.5	68.01	4.99	Ma	6.61	6	
71 486.....	8 54.1	71 42	7.12	Fo	7.27	6	
72 439.....	8 54.6	72 07	.....	B9	8.47	2	
61 1098.....	8 56.7	61 23	7.72	G5	7.76	4	
68 553.....	8 56.8	68 30	.....	Ao	8.28	5	
69 504.....	8 57.3	68 52	6.95	A5	7.30	6	S
72 441.....	8 59.2	72 43	.....	F5	7.98	7	
67 573.....	8 59.6	67 17	5.33	K2	6.92	6	
67 577.....	9 1.6	67 32	4.87	F8	5.56	6	
68 557.....	9 2.2	67 52	.....	F5	8.11	6	
69 509.....	9 2.3	69 27	.....	A2	8.27	8	
63 825.....	9 3.3	62 51	.....	A5	8.03	3	
72 444.....	9 4.3	72 04	6.46	Ko	7.50	8	
66 599.....	9 4.9	66 08	.....	Fo	7.98	4	
66 600.....	9 5.2	66 12	.....	F2	7.93	4	
73 452.....	9 5.8	73 22	5.89	A2	6.06	6	S
62 1058.....	9 6.4	61 50	5.23	F8	5.99	4	
67 581.....	9 6.6	67 33	.....	Fo	7.55	6	
74 393.....	9 9.5	74 26	6.54	G5	7.55	5	
60 1181.....	9 12.9	60 12	7.46	Ko	8.67	4	
61 1114.....	9 13.0	61 48	7.58	A5	7.96	2	
61 1118.....	9 16.6	60 52	7.48	K2	8.80	3	
60 1187.....	9 17.4	60 26	.....	Go	7.90	2	
64 733.....	9 17.7	64 23	6.46	K2	7.96	4	
64 735.....	9 18.9	64 47	8.25	A2	8.56	3	
68 572.....	9 22.7	67 58	7.22	A2	7.50	5	S P.D.M.=7.73
67 594.....	9 23.3	67 19	8.02	Fo	8.19	4	
72 462.....	9 25.4	72 39	5.82	F5	6.24	8	
70 565.....	9 25.6	70 16	4.57	Go	5.58	9	
67 597.....	9 26.0	67 14	7.37	F5	7.79	5	
74 402.....	9 26.2	74 47	6.38	B9	6.19	4	S
61 1132.....	9 27.7	61 20	7.17	Fo	7.63	4	
72 464.....	9 27.9	72 32	7.24	F5	7.89	8	
70 467.....	9 28.0	70 05	7.12	Fo	7.46	9	
73 470.....	9 28.4	73 32	6.43	Fo	6.64	8	
61 1134.....	9 28.5	61 40	.....	F5	8.79	4	
70 568.....	9 29.5	70 43	6.84	F2	7.40	7	
73 471.....	9 30.1	73 11	6.98	A3	7.20	8	
60 1198.....	9 30.2	60 39	6.56	G5	7.44	4	
69 526.....	9 30.3	69 45	8.04	Fo	8.34	6	
67 602.....	9 31.2	67 43	6.28	K5	7.71	6	S

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
72° 465.....	9 ^h 31 ^m 6	72° 12'	F5	7.98	10	S P.D.M.=8.39
69 531.....	9 33.7	69 42	5.74	Ko	7.97	7	
67 608.....	9 33.7	67 12	.....	A2	8.30	5
72 466.....	9 33.8	72 42	5.39	Ko	6.22	9	
63 858.....	9 35.6	63 23	7.87	A3	8.21	3	
65 731.....	9 36.8	65 26	6.18	F2	6.43	3	
64 752.....	9 38.2	64 07	6.50	F2	6.70	2	
63 861.....	9 40.0	63 43	6.94	G5	8.05	2	
65 736.....	9 41.0	65 22	8.08	F5	7.43	3	
60 1209.....	9 41.6	60 34	7.24	Ko	8.52	3	
67 617.....	9 41.9	67 02	F2	8.18	2	S
66 637.....	9 42.6	66 04	6.29	Fo	6.38	3	
72 473.....	9 45.3	72 09	7.58	Ao	7.74	10	
61 1151.....	9 47.8	61 36	6.42	Ko	7.68	2	
73 478.....	9 49.5	73 21	5.96	Ko	7.06	8	
69 550.....	9 53.6	69 12	.....	Fo	8.34	6
69 552.....	9 55.0	69 16	.....	F5	8.32	7
63 882.....	9 56.2	63 03	7.44	Ko	7.55	2	
64 764.....	9 56.3	64 35	.....	F2	8.58	2
67 632.....	9 57.4	67 46	7.11	Ko	8.21	5	
60 1234.....	9 57.6	60 09	A3	8.56	3	S
65 749.....	9 58.4	64 54	7.65	F2	8.05	4	
66 648.....	9 59.2	65 48	.....	F5	8.37	3
70 598.....	9 59.9	70 25	7.90	Fo	8.25	5	
67 635.....	10 0.4	67 20	.....	Go	8.28	3
69 561.....	10 1.7	69 10	7.26	Ko	8.16	5	
64 770.....	10 1.9	64 26	6.75	K5	8.39	2	
74 427.....	10 2.7	74 22	7.67	A2	7.80	6	
71 529.....	10 3.0	71 21	7.59	Ko	8.46	6	
63 886.....	10 3.2	63 25	7.12	Ko	8.22	2	
60 1250.....	10 9.2	60 39	6.75	F2	7.32	3	S
73 489.....	10 9.6	73 35	6.48	Fo	6.70	7	
65 767.....	10 10.8	65 36	5.74	A3	5.86	3	
73 491.....	10 10.9	72 57	.....	Ko	8.14	8
69 568.....	10 13.4	69 15	5.84	Fo	6.09	9	
61 1183.....	10 14.9	61 24	7.47	Ko	8.76	2	
66 664.....	10 16.9	66 04	4.92	Ao	4.86	2	
60 1263.....	10 21.1	60 05	7.01	Ko	8.15	2	
66 671.....	10 22.8	66 08	6.39	Ko	7.60	3	
74 436.....	10 23.2	73 50	7.14	Ko	8.22	5	
64 789.....	10 23.6	64 45	6.00	A3	6.25	3	S P.D.M.=6.44
74 437.....	10 23.7	74 18	8.07	Ao	8.28	5	
67 658.....	10 24.2	66 49	7.27	F2	7.63	4	
74 438.....	10 26.1	74 21	7.52	A3	7.61	6	
68 611.....	10 27.1	68 03	.....	Fo	8.27	2

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
69° 576.....	10 ^h 27 ^m 5	69° 22'	.....	A5	8.42	5	
64 795.....	10 29.2	64 07	.....	F2	8.32	2	
60 1274.....	10 31.8	60 38	6.87	F8	7.39	3	
70 620.....	10 32.5	70 40	.....	F8	8.46	6	
74 440.....	10 33.2	74 18	7.67	F5	8.00	6	
69 583.....	10 34.7	68 58	5.90	Ko	7.21	9	
66 678.....	10 35.2	66 14	5.12	Ko	6.49	3	
69 584.....	10 35.4	69 08	8.08	A3	8.38	5	
69 586.....	10 35.9	69 36	5.23	Ko	6.42	9	
66 682.....	10 41.1	65 59	7.58	F8	8.20	3	
60 1289.....	10 41.1	60 38	7.22	Fo	7.50	2	
65 803.....	10 42.1	65 40	6.24	B9	6.36	3	S
64 810.....	10 42.9	64 19	6.58	Ko	7.78	2	
70 634.....	10 46.8	70 23	6.08	G5	6.94	10	
64 814.....	10 47.1	64 05	.....	Go	8.44	2	
70 640.....	10 51.9	70 21	8.01	Fo	8.21	8	
64 824.....	10 54.8	63 58	6.34	Ao	6.43	4	S
71 557.....	10 55.7	70 56	.....	A2	8.34	6	
74 452.....	10 55.8	74 11	.....	F8	8.41	4	
70 645.....	10 56.8	70 35	6.64	Ko	7.84	7	
62 1160.....	10 57.2	62 12	7.12	F8	7.37	3	
65 817.....	10 59.3	65 21	7.22	Fo	7.69	5	
66 607.....	10 59.8	66 25	7.67	G5	8.36	2	
72 515.....	11 1.6	72 28	6.87	Fo	8.31	7	
68 632.....	11 3.3	67 45	6.09	A5	6.30	7	S P.D.M.=6.37.
67 684.....	11 3.6	67 17	.....	Fo	8.24	5	
64 834.....	11 3.6	63 51	7.87	F5	8.29	3	
69 602.....	11 5.8	68 50	6.42	A2	6.50	7	
61 1226.....	11 6.2	61 44	.....	A2	7.37	3	S
67 686.....	11 6.5	67 33	.....	F2	8.36	3	
68 635.....	11 6.9	67 52	.....	G5	7.62	9	
63 947.....	11 8.0	62 48	7.77	G5	8.51	2	
72 526.....	11 8.4	72 33	7.34	B9	7.60	8	S
74 456.....	11 8.7	74 01	7.18	K5	8.18	5	
65 823.....	11 9.9	65 27	7.07	Ko	8.21	5	
70 654.....	11 10.3	69 45	8.14	Go	8.42	3	
60 1318.....	11 10.4	60 28	6.66	A3	6.97	4	
68 639.....	11 11.5	68 25	.....	F2	8.32	6	
61 1235.....	11 11.6	60 49	6.74	Ko	7.71	4	
67 691.....	11 12.7	67 13	7.12	Fo	7.33	8	
64 841.....	11 12.9	64 03	.....	F2	8.32	4	
62 1172.....	11 13.1	62 43	7.02	Ko	8.09	4	
63 952.....	11 14.7	62 54	.....	F2	8.16	4	
67 692.....	11 14.8	67 38	6.31	Ko	7.32	8	
65 828.....	11 16.9	64 53	5.98	Ao	6.00	7	S

CATALOGUE—Continued

B.D. No.	R A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
63° 957.....	11 ^h 17 ^m 4	63° 14'	.....	Fo	8.18	4	
65 830.....	11 18.4	65 36	.....	F8	7.80	5	
67 609.....	11 20.8	67 26	.....	F5	8.32	6	
69 608.....	11 21.6	68 59	.....	A2	8.25	4	
64 848.....	11 23.2	64 07	7.62	F5	8.04	3	
68 644.....	11 23.3	67 59	7.27	Ko	8.28	5	
62 1183.....	11 23.4	62 19	5.86	Fo	6.08	3	
67 701.....	11 23.5	67 29	7.49	F2	7.81	8	
68 645.....	11 24.2	68 41	.....	A2	8.21	2	
70 665.....	11 25.5	69 53	4.06	Ma	5.78	5	
61 1246.....	11 26.7	61 38	5.47	F5	5.88	4	
68 650.....	11 28.3	68 08	.....	A5	8.22	5	
66 724.....	11 28.4	65 48	7.22	F8	7.80	5	
74 404.....	11 21.1	73 57	.....	F5	8.45	2	
70 670.....	11 30.2	69 53	5.36	G5	6.33	9	
67 709.....	11 30.5	66 54	.....	F5	8.08	6	
63 972.....	11 32.1	63 15	7.32	F2	7.50	4	
64 857.....	11 32.8	64 43	7.85	Ao	7.66	6	
65 843.....	11 33.3	64 53	6.44	A2	6.47	6	S
69 618.....	11 33.6	69 24	.....	F5	8.46	6	
63 974.....	11 34.8	62 57	7.02	F5	7.53	3	
60 1339.....	11 35.3	60 39	7.79	Fo	7.94	4	
61 1258.....	11 35.6	61 24	7.17	G5	7.71	4	
67 714.....	11 36.9	67 18	5.48	K2	6.66	8	
73 532.....	11 38.9	73 42	7.24	K2	8.42	2	
70 674.....	11 39.5	70 29	7.62	A2	7.78	7	S
65 851.....	11 41.6	64 57	7.45	Ao	7.55	6	S
62 1198.....	11 41.7	61 58	6.64	Fo	7.08	4	
68 662.....	11 43.7	67 53	7.17	F8	7.62	7	
69 628.....	11 45.9	69 24	7.09	A2	7.33	10	
63 982.....	11 47.8	63 19	.....	A2	8.32	2	
74 475.....	11 47.9	73 51	7.64	Ko	8.36	2	
74 476.....	11 48.3	74 19	6.78	F8	7.26	6	
72 550.....	11 48.8	72 28	7.54	F5	8.00	9	
72 551.....	11 49.0	72 42	.....	A3	8.30	7	
73 537.....	11 49.8	72 57	.....	F5	8.42	3	
68 665.....	11 50.3	67 49	7.47	Go	7.76	8	
66 737.....	11 51.4	65 47	6.72	G5	7.56	5	
62 1204.....	11 51.7	62 06	6.28	G5	7.10	4	
63 987.....	11 52.1	62 47	.....	F5	8.33	3	
68 667.....	11 52.8	68 22	7.07	K2	8.16	7	
62 1206.....	11 53.1	62 02	6.66	G5	7.70	4	
62 1207.....	11 54.1	61 53	7.52	A3	7.55	4	S
72 554.....	11 54.4	72 08	.....	F5	8.36	2	
69 636.....	11 55.5	69 45	7.32	Fo	7.71	8	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
71° 598.....	11 ^h 55 ^m 7	70° 47'	6.69	Ao	6.78	10	S
71 599.....	11 56.5	71 25	7.36	Ko	8.28	3	
65 853.....	11 56.5	65 30	7.25	A3	7.36	5	S
69 638.....	11 58.5	69 35	7.10	K2	8.39	6	
67 730.....	11 59.5	66 54	7.87	F8	8.21	6	
69 642.....	12 0.5	69 18	8.07	Ma	8.1-8.6	8	Var.
63 999.....	12 0.6	63 30	6.24	Ko	7.46	4	
69 644.....	12 1.1	69 15	7.14	F5	7.48	8	
69 645.....	12 2.3	69 38	7.91	G5	8.40	3	
72 558.....	12 3.0	72 19	.....	A2	8.30	7	
66 746.....	12 3.6	65 54	.....	F8	8.17	5	
75 469.....	12 4.9	75 13	6.36	F5	6.81	4	
67 735.....	12 8.2	67 38	.....	F8	8.38	2	
61 1283.....	12 8.2	60 57	.....	A2	8.41	4	
66 751.....	12 9.2	66 40	6.78	Ko	8.07	6	
71 610.....	12 10.4	70 45	5.89	Ko	7.00	10	
73 549.....	12 11.0	73 07	6.55	Ko	7.57	8	
64 887.....	12 11.9	64 11	.....	F8	8.47	3	
61 1289.....	12 13.5	60 53	.....	G5	8.46	5	
75 470.....	12 14.4	75 43	5.41	A2	5.53	4	S
63 1009.....	12 14.9	62 55	7.72	A3	7.91	5	S
67 742.....	12 15.6	66 57	7.12	Ao	6.99	8	S
64 890.....	12 15.8	64 14	7.37	G5	8.12	5	
62 1228.....	12 17.3	62 09	6.86	G5	7.79	4	
61 1292.....	12 18.9	61 28	7.69	G5	8.36	4	
61 1294.....	12 20.3	61 14	7.41	Go	7.68	5	
64 896.....	12 20.4	64 22	6.37	G5	7.24	5	
72 565.....	12 22.1	72 29	6.44	Ko	7.48	10	
61 1295.....	12 22.9	61 42	7.85	A2	7.90	5	S
66 761.....	12 23.8	66 02	8.08	F2	8.19	3	
67 746.....	12 24.8	67 27	7.02	G5	7.96	8	
70 700.....	12 25.7	69 45	5.25	Ma	6.78	10	
66 763.....	12 26.4	66 27	6.72	A3	6.96	8	S
72 569.....	12 26.7	71 52	7.02	Ko	8.04	10	
69 666.....	12 27.5	69 03	7.42	F5	7.80	7	
72 570.....	12 27.7	72 44	.....	A2	8.06	8	
73 559.....	12 29.4	73 02	7.37	F8	7.91	8	
70 705.....	12 30.5	70 34	5.18	Ko	6.30	9	
69 669.....	12 31.6	69 34	7.42	G5	8.02	7	
70 707.....	12 32.7	70 44	6.72	K2	8.14	5	
72 575.....	12 34.3	72 41	.....	Ao	8.08	6	
61 1309.....	12 35.1	61 26	7.10	Ko	7.99	6	
73 561.....	12 35.6	73 33	7.44	Ko	8.11	6	
60 1416.....	12 35.9	60 05	7.87	A3	7.98	4	
69 671.....	12 36.1	69 20	.....	F8	8.56	5	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
64° 914.....	12 ^h 36 ^m .4	64° 19'	7.50	F5	7.82	5	S
63 1026.....	12 37.2	63 16	5.92	Ao	5.82	5	
61 1312.....	12 38.7	61 42	6.46	Ko	7.59	5	
66 768.....	12 39.1	66 29	7.48	F2	7.88	4	
72 578.....	12 40.1	72 37	.....	A3	8.10	6
72 579.....	12 40.8	72 39	Ko	8.22	4	S
63 1034.....	12 43.0	63 20	5.83	A5	5.96	4	
67 704.....	12 43.5	67 20	5.67	K5	7.05	8	
71 630.....	12 44.1	71 29	7.32	K5	8.27	4	
61 1320.....	12 44.3	60 52	5.87	F5	6.08	4	
62 1257.....	12 44.7	61 55	7.32	Go	7.80	4	S P.D.M. = 7.57
65 003.....	12 44.8	65 17	.....	Fo	7.92	6
63 1037.....	12 46.7	63 31	7.16	A3	7.64	3	
70 715.....	12 47.4	69 50	7.94	Ao	7.97	9	
72 588.....	12 49.1	72 06	.....	A5	7.98	8
60 1426.....	12 49.4	60 03	Fo	8.02	4	
66 778.....	12 51.5	65 59	5.27	Fo	5.48	6	
69 677.....	12 52.9	69 08	7.38	G5	8.34	6	
68 703.....	12 53.1	67 47	6.66	Ko	8.09	7	
71 636.....	12 53.6	71 18	.....	Fo	7.94	8
65 913.....	12 54.4	65 27	6.56	Ko	7.75	6	
69 680.....	12 54.5	69 14	7.42	G5	8.40	5	
69 681.....	12 55.3	69 19	.....	Go	8.52	3
71 638.....	12 55.5	71 08	7.12	K2	8.30	8	
67 773.....	12 56.2	68 08	5.50	Ko	6.65	8	
64 927.....	12 57.9	64 09	6.02	F5	6.35	4	S
60 1439.....	12 58.6	60 16	6.33	Ao	6.39	4	
72 599.....	12 59.7	72 15	.....	Fo	7.92	8
73 581.....	13 0.8	72 56	.....	Ao	8.00	7
62 1274.....	13 1.5	62 36	.....	A2	8.55	3
62 1275.....	13 2.4	62 35	6.31	Ko	7.22	5	S
63 1053.....	13 4.3	63 14	.....	Ko	8.73	2
74 521.....	13 5.1	73 53	.....	Ao	7.72	7
63 1056.....	13 5.9	62 47	6.49	Ao	6.45	4	
66 796.....	13 7.0	66 06	.....	A3	8.17	2
63 1057.....	13 7.6	63 42	7.48	F5	8.06	4	S
68 717.....	13 9.6	67 52	7.04	Ko	8.20	7	
68 720.....	12 10.1	67 49	6.75	Ko	7.58	6	
73 587.....	13 10.7	73 20	6.43	Ao	6.52	6	
64 938.....	13 12.3	64 10	.....	F5	8.42	2
69 694.....	13 13.2	68 56	6.11	B0	6.05	6	S
72 608.....	13 14.7	71 46	.....	F8	8.16	8
68 723.....	13 14.9	68 13	7.32	Ko	8.34	2	
67 780.....	13 15.6	67 44	.....	F5	8.24	3
60 1458.....	13 16.3	60 23	.....	F8	8.34	4

CATALOGUE—Continued

B.D. No.	R A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
61° 1350.....	13 ^b 16 ^m 4	60° 56'	G5	8.27	4	S
62 1288.....	13 16.7	61 56	8.03	A2	8.15	3	
70 736.....	13 17.3	70 10	7.99	F5	8.38	6	
60 696.....	13 17.6	69 38	7.24	G5	8.18	7	
63 1071.....	13 19.9	63 19	7.98	Go	8.45	3	
64 949.....	13 22.6	63 46	6.55	G5	7.33	5	S
73 592.....	13 23.6	72 55	6.07	K5	7.61	6	
71 651.....	13 24.4	76 51	7.46	Fo	7.68	5	
60 1461.....	13 24.8	60 28	5.41	Ao	5.36	4	
70 741.....	13 25.3	70 38	7.52	Ko	8.24	5	
64 951.....	13 26.5	64 42	7.05	Go	7.94	4	S
71 654.....	13 28.8	70 56	7.84	A5	8.17	6	
61 1366.....	13 30.2	60 46	6.95	Ko	7.95	3	
65 946.....	13 31.6	65 46	.....	F2	8.38	6
70 747.....	13 32.4	70 37	7.31	Ao	7.41	7	
67 790.....	13 34.0	67 33	6.80	G5	7.84	7	S
71 659.....	13 34.8	71 45	5.67	Ko	6.69	8	
67 792.....	13 35.1	67 07	7.79	A2	7.98	6	
64 961.....	13 37.9	64 22	.....	F5	8.54	3
65 953.....	13 38.4	65 20	5.70	Ao	5.85	5	
66 816.....	13 39.0	65 47	6.55	A2	6.69	5	S
60 1485.....	13 40.5	60 39	7.06	Ao	7.15	6	
65 957.....	13 41.2	65 31	.....	F5	8.29	4
69 716.....	13 41.9	69 43	8.14	F5	8.54	7	
65 961.....	13 42.5	65 07	7.80	A2	8.12	7	
69 717.....	13 42.7	69 30	7.89	F8	8.32	6	S
62 1318.....	13 46.5	61 59	6.05	Ko	6.87	5	
61 1381.....	13 46.8	61 02	7.70	Ao	7.88	5	
72 628.....	13 47.4	72 36	.....	Go	8.29	4
70 760.....	13 47.6	70 19	.....	Ao	8.22	4
66 821.....	13 47.7	66 29	Fo	8.35	4	S
65 963.....	13 48.5	65 13	4.77	Ma	6.28	6	
62 1322.....	13 51.2	62 36	.....	Ko	8.30	3
69 726.....	13 51.3	69 45	8.24	A3	8.31	4	
63 1102.....	13 51.6	62 53	7.26	Ko	8.16	4	
63 1103.....	13 52.8	63 39	F2	8.08	4	S
70 762.....	13 53.4	70 27	7.38	Ko	8.26	4	
66 825.....	13 53.6	65 42	7.58	F5	8.28	5	
63 1105.....	13 54.1	63 18	7.32	F5	7.71	4	
62 1325.....	13 54.4	61 59	6.40	K5	7.43	6	
65 966.....	13 55.7	65 24	6.99	Ko	8.15	7	S
66 827.....	13 56.0	66 36	.....	F8	7.93	6
65 964.....	13 56.4	64 53	7.20	K2	8.18	6	
60 1505.....	13 58.0	60 03	.....	F8	8.44	5
63 1109.....	13 58.5	73 53	7.68	G5	8.10	4	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
69° 733.....	13 ^h 59 ^m 6	69° 10'	B8	7.98	7	S
62 1327.....	13 59.8	62 10	7.30	A2	7.61	4	
62 1328.....	13 59.9	62 46	.....	Fo	8.26	4
70 769.....	14 1.5	70 46	7.69	K5	8.29	4	
70 774.....	14 7.6	70 04	7.14	B9	7.20	7	S
69 736.....	14 8.1	69 20	6.56	Ko	7.96	7	
63 1120.....	14 8.1	62 59	.....	F5	8.27	3
61 1409.....	14 8.7	60 57	8.00	F5	8.19	6	
70 778.....	14 10.2	69 54	5.36	Ma	6.93	7	
63 1121.....	14 10.6	63 09	7.67	Fo	8.04	5	
65 987.....	14 13.5	65 18	7.16	Ao	7.51	5	S P.D.M.=7.53
63 1123.....	14 13.8	63 32	.....	F8	8.39	3
63 1125.....	14 15.2	63 13	.....	Ao	8.41	4
69 741.....	14 15.9	69 12	7.34	F2	7.93	6	
65 991.....	14 16.7	64 50	8.05	A5	8.26	5	
67 831.....	14 17.4	67 34	A3	8.30	5	S
63 1128.....	14 17.6	63 40	.....	A2	8.33	5
68 777.....	14 18.0	68 15	6.71	Ao	6.77	6	
66 842.....	14 18.8	65 49	7.00	F5	7.64	5	
68 781.....	14 19.2	68 16	7.09	A2	7.24	5	S P.D.M.=7.37
62 1345.....	14 19.3	62 44	Ao	8.38	3	
61 1422.....	14 19.7	61 26	7.23	Go	7.76	6	
60 1534.....	14 19.7	60 14	7.61	Ko	8.27	6	
63 1131.....	14 22.3	63 24	7.13	F8	7.72	5	
66 847.....	14 23.3	66 26	7.14	F2	7.64	5	
60 1541.....	14 24.8	60 10	7.96	F5	7.89	4	S
61 1432.....	14 26.2	60 50	7.32	A2	7.44	4	
69 749.....	14 26.4	69 42	7.79	Go	8.28	6	
76 527.....	14 27.7	76 08	4.37	K2	6.22	3	
73 631.....	14 27.8	73 30	A2	8.19	4	
63 1136.....	14 28.4	63 38	6.04	F5	6.50	2	S
60 1547.....	14 29.0	60 40	6.18	Fo	6.32	4	
68 787.....	14 29.1	68 31	7.18	A3	7.59	4	
70 792.....	14 30.3	70 41	.....	F2	8.27	4
66 855.....	14 31.5	14 50	6.63	F5	6.95	4	
63 1141.....	14 32.1	63 38	7.38	K2	8.53	2	S P.D.M.=8.34
67 843.....	14 32.6	67 14	7.54	F8	8.00	3	
66 856.....	14 32.8	66 25	7.87	Fo	8.09	4	
64 1114.....	14 34.0	63 54	7.84	A3	8.25	2	
64 1017.....	14 36.9	64 43	7.45	F8	8.10	4	
64 1018.....	14 37.2	64 35	7.50	F2	7.87	3	
66 863.....	14 37.8	66 46	7.43	G5	7.84	3	
72 650.....	14 38.3	72 42	7.95	F5	8.24	5	
61 1451.....	14 39.5	61 41	6.17	F2	6.38	6	
60 1557.....	14 39.9	60 39	Fo	8.11	5	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
61° 1454.....	14 ^h 41 ^m 6	61° 32'	6.60	F2	6.98	5	S P.D.M. = 7.58
69 1560.....	14 42.0	60 29	7.46	Ko	8.35	4	
65 1011.....	14 43.3	65 47	.....	F5	7.63	3
65 1012.....	14 44.0	65 03	7.85	Ao	8.00	3	
60 1507.....	14 44.5	60 08	7.21	A2	7.40	4	
72 652.....	14 45.3	72 23	7.40	A5	7.50	5	S P.D.M. = 8.00
62 1368.....	14 45.3	61 59	.....	A2	7.89	5
65 1015.....	14 45.7	65 39	7.22	A5	7.90	3	
72 653.....	14 47.1	72 02	7.77	F2	8.00	4	
73 646.....	14 50.1	73 27	.....	A2	7.59	4
70 813.....	14 52.7	70 10	7.64	K5	8.41	2	S
66 878.....	14 56.0	66 20	4.86	Mb	6.37	3	
62 1380.....	14 56.5	62 04	7.04	A2	7.06	4	
66 882.....	14 58.3	65 52	6.95	Ko	8.01	3	
60 1582.....	14 59.1	60 36	5.89	A2	5.86	6	
71 706.....	14 59.6	71 00	7.64	F8	8.12	4	Var.?
72 664.....	15 0.4	72 09	6.66	Go	7.20	3	
60 1584.....	15 1.1	60 26	6.81	K5	.....	5
68 817.....	15 1.3	68 16	.....	F8	8.39	3
66 886.....	15 1.4	66 10	7.26	Go	7.86	3	
66 887.....	15 2.4	66 18	7.09	Ao	7.11	3	S
60 1589.....	15 4.0	60 12	7.51	F2	7.87	4	
66 889.....	15 5.0	66 07	.....	Ao	8.32	2
74 602.....	15 5.6	74 16	7.15	Ao	7.57	2	
65 1036.....	15 5.9	65 06	7.30	Ko	8.46	2	
63 1167.....	15 5.9	63 30	6.75	F2	7.08	2	S
66 890.....	15 6.8	66 11	6.82	Ma	8.45	2	
65 1039.....	15 7.0	64 56	7.20	Ko	8.14	2	
70 827.....	15 8.4	70 02	7.04	F2	7.29	2	
72 671.....	15 8.5	72 44	.....	Go	7.28	2
68 823.....	15 9.7	68 10	6.15	A2	6.24	4	S P.D.M. = 8.12
66 894.....	15 9.9	66 01	7.66	A2	8.02	3	
62 1392.....	15 9.9	62 13	7.34	Go	7.80	5	
67 876.....	15 13.5	67 44	5.23	Go	5.74	4	
69 789.....	15 14.1	69 18	6.50	Ao	6.38	2	
63 1182.....	15 15.4	63 08	6.77	Ko	7.80	3	S
69 793.....	15 17.0	69 31	7.34	Ko	8.21	2	
63 1185.....	15 17.1	63 31	.....	A3	8.35	2
72 647.....	15 17.2	72 11	5.14	Ko	6.54	4	
71 722.....	15 17.2	71 34	7.19	F8	7.52	3	
65 1048.....	15 17.2	65 47	A2	7.88	3	S
61 1495.....	15 17.3	61 43	7.33	Go	7.82	4	
60 1605.....	15 17.8	60 42	7.62	F2	7.92	4	
62 1406.....	15 18.0	62 50	6.64	K2	7.97	3	
60 1606.....	15 18.0	60 44	7.44	Fo	7.66	4	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
74° 609.....	15 ^h 18 ^m 3	74° 24'	6.66	Ko	7.79	2	
67 883.....	15 18.8	67 22	.....	A5	8.25	3	
62 1410.....	15 20.7	62 23	5.80	B9	5.83	3	S
63 1192.....	15 21.0	63 42	5.78	K5	7.19	3	
63 1194.....	15 21.3	63 28	7.39	Ko	8.36	3	
63 1195.....	15 22.1	63 17	.....	F5	8.19	2	
73 672.....	15 22.3	73 50	7.36	F5	7.77	2	
62 1414.....	15 25.8	62 37	6.37	Ao	6.54	3	S P.D.M.=6.70
61 1509.....	15 25.9	61 01	6.08	K5	7.51	4	
62 1415.....	15 26.8	62 05	6.79	Ao	6.82	5	
62 1416.....	15 27.6	62 27	6.40	K5	7.76	3	
64 1074.....	15 29.5	64 33	5.88	G5	6.72	3	
67 901.....	15 30.0	67 01	.....	Fo	8.34	2	
68 842.....	15 33.9	68 08	6.90	G5	7.66	4	
65 1062.....	15 34.0	65 36	7.50	A2	7.55	5	S
69 806.....	15 37.4	69 36	5.86	Ko	7.09	5	
66 915.....	15 37.5	66 07	7.06	Ko	8.29	5	
71 741.....	15 38.0	71 29	7.12	Ko	8.00	3	
69 808.....	15 38.4	69 08	.....	F5	7.75	5	
67 912.....	15 40.0	67 38	.....	A2	7.29	3	
67 916.....	15 43.8	67 37	.....	F2	8.29	2	
69 812.....	15 44.4	68 59	7.21	A2	7.35	5	S
63 1225.....	15 45.1	62 54	5.13	A2	5.30	3	S P.D.M.=5.43
66 920.....	15 45.6	66 10	.....	A3	8.41	3	
69 813.....	15 46.9	69 47	7.44	A2	7.50	6	S
62 1431.....	15 46.9	62 40	.....	A2p	8.33	3	
70 846.....	15 47.0	70 41	7.70	F8	8.06	4	
60 1637.....	15 47.5	60 50	7.81	F5	8.04	5	
63 1228.....	15 47.7	63 28	.....	Fo	8.33	2	
65 1081.....	15 49.0	65 06	7.15	Ao	7.32	3	S
66 923.....	15 49.9	66 43	.....	A3	8.18	5	
65 1087.....	15 52.5	65 34	6.90	G5	7.77	5	
69 825.....	15 53.4	64 01	6.82	F5	7.15	8	
72 703.....	15 56.6	77 41	7.46	Ko	8.20	3	
66 927.....	15 58.1	66 20	.....	A3	8.30	4	
71 762.....	15 58.9	71 10	7.42	G5	7.79	5	
68 858.....	16 0.0	67 59	6.82	F2	7.37	7	
65 1095.....	16 0.0	65 14	7.10	A2	7.12	5	S
74 650.....	16 1.9	74 13	7.96	Ko	8.64	2	
71 767.....	16 4.6	71 24	.....	A2	8.17	5	
65 1098.....	16 5.1	64 57	7.30	Ko	8.35	2	
70 863.....	16 5.2	70 32	6.74	Ao	6.68	5	S
73 707.....	16 5.4	73 25	6.95	F5	7.17	4	
68 864.....	16 6.1	68 04	5.40	Ao	5.33	7	S
63 1253.....	16 8.2	63 40	6.71	A3	6.90	3	S

CATALOGUE—*Continued*

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
60° 1658.....	16 ^h 8 ^m 2	60° 08'	6.70	Ao	6.58	3	S
71 768.....	16 11.7	71 34	8.28	F5	8.28	4	
72 718.....	16 11.8	72 39	7.78	Ao	7.91	4	
67 930.....	16 12.1	67 24	6.28	Ko	7.27	8	
66 941.....	16 12.8	66 52	.....	Go	8.40	3
72 770.....	16 14.5	72 01	A3	8.31	4	
71 775.....	16 15.5	71 11	7.77	G5	8.22	5	
60 1665.....	16 15.6	60 00	5.64	Mb	7.09	3	
73 713.....	16 16.2	73 38	5.98	Ao	5.85	3	
68 868.....	16 18.2	68 48	6.47	Ko	7.71	4	
70 874.....	16 20.1	70 36	7.46	F8	7.86	5	
62 1476.....	16 21.5	61 55	.....	G5	6.48	4
69 845.....	15 22.0	69 20	5.44	Ko	6.36	7	
70 877.....	16 22.3	70 44	7.28	Ko	8.16	5	
61 1591.....	16 22.6	61 44	2.89	G5	4.66	3	
67 941.....	16 25.1	67 18	7.40	Ko	8.45	6	
71 789.....	16 26.5	71 36	7.16	F8	7.48	5	
67 942.....	16 28.1	67 16	6.73	Ma	8.30	6	
69 850.....	16 28.2	68 59	4.98	B8p	4.88	7	
65 1122.....	16 28.3	65 00	7.75	Go	8.29	4	
63 1278.....	16 29.5	63 47	7.90	Fo	8.28	2	
67 945.....	16 30.2	67 34	8.48	Go	8.56	2	
61 1598.....	16 31.0	61 02	5.85	Ao	5.89	3	
63 1281.....	16 31.6	63 04	7.22	Fo	7.63	3	
61 1599.....	16 32.0	61 26	.....	Ao	7.58	3
71 797.....	16 32.7	71 08	F5	8.22	7	
72 734.....	16 33.0	72 49	6.45	Ko	7.64	5	
63 1284.....	16 33.6	63 28	.....	K2	7.89	3
68 879.....	16 34.0	68 13	7.28	Ko	8.56	3	
62 1492.....	16 34.7	62 34	.....	F2	8.23	2
61 1604.....	16 36.9	61 23	7.01	K5	8.26	5	
70 887.....	16 37.2	70 00	8.04	F5	8.22	9	
69 860.....	16 38.4	69 22	.....	Fo	7.88	7
68 880.....	16 39.4	68 31	.....	Go	8.53	3
62 1501.....	16 40.0	62 30	7.24	B8	7.06	3	
64 1145.....	16 40.2	64 47	5.00	Ko	6.03	5	
64 1147.....	16 41.2	64 00	.....	G5	8.21	2
72 745.....	16 42.5	72 51	6.94	Ma	8.29	4	
68 883.....	16 42.9	68 17	7.65	G5	8.59	2	
61 1609.....	16 43.0	61 09	7.72	Ao	7.92	5	
65 1141.....	16 43.7	65 25	Ko	8.48	3	S
74 680.....	16 44.2	74 04	6.76	A2	6.79	3	
63 1303.....	16 45.8	62 57	.....	A2	8.05	4
68 884.....	16 45.9	68 26	.....	Go	8.85	3
63 1307.....	16 46.4	63 42	7.07	K5	8.16	2	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
66° 975.....	16 ^h 46 ^m 5	66° 13'	A2	8.08	6	S
67 969.....	16 47.0	67 26	7.22	K2	8.78	3	
60 872.....	16 47.8	60 16	7.36	A0	7.52	6	
60 1706.....	16 47.8	60 18	.....	F2	8.19	4
68 888.....	16 47.9	68 01	7.66	K0	8.60	3	
70 899.....	16 48.6	70 17	.....	G5	8.33	5
72 754.....	16 49.4	72 07	F8	8.40	3	
67 971.....	16 49.5	67 46	.....	K0	8.95	3
60 891.....	16 49.7	60 05	.....	A2	8.56	5
67 984.....	16 51.7	67 49	.....	G5	8.59	3
68 893.....	16 52.1	68 05	.....	A0	7.49	7
60 1713.....	16 52.7	60 32	7.16	K0	8.34	4	
61 1619.....	16 52.9	61 48	G0	8.40	5	
62 1520.....	16 53.8	.....	7.04	G5	7.59	2
62 1521.....	16 55.3	62 31	6.79	A0	6.80	4	
70 906.....	16 55.4	70 37	6.95	A2	6.90	6	
65 1157.....	16 55.5	65 17	4.82	F5	5.30	8	
61 1623.....	16 55.6	61 38	7.32	K0	8.22	5	
67 977.....	16 55.8	67 38	6.72	A0	6.64	7	
65 1159.....	16 55.9	65 11	6.44	F0	6.54	8	
74 690.....	16 56.2	74 27	7.62	F0	7.59	2	
73 751.....	16 58.3	73 17	6.24	A5	6.22	4	
71 817.....	16 58.7	71 36	.....	G5	8.42	6
74 695.....	16 58.8	74 26	7.17	F5	7.50	3	
69 884.....	16 59.6	69 20	6.52	K0	7.12	7	S
68 908.....	16 59.7	68 50	7.32	A5	7.82	8	
60 1728.....	17 0.1	60 47	6.24	K0	7.15	6	
64 1170.....	17 1.7	64 44	6.09	K0	7.24	7	
61 1636.....	17 2.9	61 18	.....	K0	8.65	5
73 755.....	17 3.4	73 27	7.70	K2	8.36	2	
71 822.....	17 4.1	71 12	7.64	K5	8.53	6	
69 891.....	17 4.4	69 55	7.89	F5	8.27	9	
61 1640.....	17 7.0	61 17	6.69	F5	7.28	4	
72 768.....	17 10.1	72 15	7.58	K2	8.35	5	
61 1645.....	17 10.7	61 56	.....	F2	8.22	5
66 999.....	17 10.8	66 23	.....	A2	7.78	7
73 759.....	17 10.9	73 17	A2	8.18	4	S P.D.M. = 5.68
63 1334.....	17 11.1	63 15	.....	A2	8.16	4
63 1336.....	17 11.7	62 59	5.47	A3	5.69	5	
67 995.....	17 12.9	67 44	.....	A3	8.47	7
60 1742.....	17 14.9	60 49	6.73	F0	7.10	5	
64 1191.....	17 17.0	64 08	7.18	K2	7.96	4	
71 835.....	17 17.8	71 54	6.81	K2	7.96	7	S
63 1343.....	17 18.3	63 50	7.22	A0	7.46	4	
70 925.....	17 20.2	70 53	7.00	A0	7.11	7	S

CATALOGUE—Continued

B.D. No.	R A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
65° 1176.....	17 ^h 20 ^m 4	65° 44'	7.62	F2	8.20	5	
61 1656.....	17 20.7	61 49	.....	F5	8.64	4	
69 910.....	17 20.9	69 51	7.14	K2	8.37	10	
66 1013.....	17 20.9	66 39	7.03	K2	8.30	7	
69 911.....	17 22.0	69 54	7.39	F8	7.98	9	
61 1650.....	17 22.5	61 06	7.21	Ko	8.48	4	
73 707.....	17 22.9	73 06	.....	Ko	8.68	3	
60 1754.....	17 24.4	60 07	5.66	Ao	5.74	4	S
71 841.....	17 24.9	71 57	7.05	Mb	8.58	4	
67 1014.....	17 25.3	67 23	6.31	Ko	7.25	5	
73 772.....	17 26.4	73 02	.....	Ko	8.54	3	
67 1015.....	17 26.6	67 51	.....	A5	7.84	7	
73 774.....	17 27.6	73 18	.....	Ao	8.52	3	
72 791.....	17 28.5	72 53	7.55	Ko	8.33	3	
68 932.....	17 28.8	68 34	.....	A2	8.42	7	
63 1358.....	17 29.1	63 56	7.43	Go	8.34	3	P.D.M. = 7.83
71 845.....	17 31.1	71 22	.....	Ao	8.46	5	
74 713.....	17 31.3	74 34	8.17	F2	8.34	2	
69 925.....	17 32.1	69 40	7.32	Ko	8.23	9	
68 938.....	17 32.4	68 12	5.21	Ko	6.07	7	
67 1019.....	17 32.8	67 03	.....	F2	8.38	4	
71 846.....	17 32.9	71 19	7.76	K2	8.72	2	
60 1704.....	17 32.9	60 09	.....	F5	7.70	4	
67 1021.....	17 33.5	67 16	.....	F2	8.08	5	
61 1678.....	17 33.9	61 58	5.31	F8	5.71	4	
74 717.....	17 35.5	74 17	7.06	K2	7.63	4	
63 1362.....	17 35.8	63 23	.....	A3	8.22	2	
61 1683.....	17 36.1	61 01	.....	A5	8.54	4	
69 930.....	17 36.4	69 20	.....	Ko	8.30	7	
62 1561.....	17 36.7	62 00	.....	Ao	7.90	5	
67 1027.....	17 37.2	67 11	.....	A2	8.16	5	
69 933.....	17 37.5	69 38	6.48	F8	6.82	8	
68 949.....	17 37.5	68 48	4.87	F5	5.13	8	
73 782.....	17 38.0	73 07	.....	Ao	7.86	3	
72 799.....	17 38.5	72 66	7.28	Ao	7.52	5	
74 720.....	17 38.8	74 04	7.62	F5	8.22	3	
72 800.....	17 39.0	72 30	5.96	Ko	6.92	6	
63 1371.....	17 39.7	63 43	6.83	F5	7.26	3	
69 939.....	17 41.0	69 12	7.08	F2	7.41	9	
67 1031.....	17 41.6	67 12	6.87	K5	8.40	7	
73 786.....	17 41.9	72 59	.....	F2	8.20	5	
73 787.....	17 42.0	73 01	.....	A	8.11	5	
72 803.....	17 43.1	72 27	.....	Ko	8.22	5	
72 804.....	17 43.7	72 12	4.90	F5	4.79	5	
73 791.....	17 44.4	73 30	7.64	Ao	7.78	3	S

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
69° 946.....	17 ^h 44 ^m 7	69° 07'	.....	F8	8.27	7	
63 1377.....	17 46.5	63 09	7.76	A2	7.97	3	S
64 1222.....	17 48.3	64 48	7.55	Ao	6.80	6	S
62 1573.....	17 48.4	62 50	6.69	F2	6.88	3	
68 961.....	17 49.6	68 22	.....	A2	7.79	8	
73 796.....	17 49.8	73 10	7.52	Go	8.28	4	
68 963.....	17 50.0	68 43	6.87	A2	7.08	7	S
69 951.....	17 51.1	69 12	.....	A2	8.50	6	
60 1787.....	17 51.2	60 25	6.82	A2	6.96	3	
61 1707.....	17 52.5	61 04	7.78	F8	8.43	3	
63 1388.....	17 52.6	63 04	.....	F2	8.30	2	
66 1057.....	17 52.9	66 26	7.67	Ko	8.50	3	
65 1220.....	17 54.3	65 02	8.25	F8	8.40	2	
61 1710.....	17 54.7	61 25	6.82	A3	7.49	3	S P.D.M.=7.55
74 740.....	17 55.4	74 35	6.83	A3	6.86	2	S
69 958.....	17 56.1	69 38	7.12	Fo	7.87	8	
73 803.....	17 56.2	73 08	.....	K2	8.75	4	
72 818.....	17 56.9	72 01	5.54	F2	5.63	4	
60 1798.....	17 58.9	60 28	7.91	A3	8.33	5	S P.D.M.=8.56
63 1399.....	17 59.6	63 33	7.10	K2	8.26	5	
71 864.....	18 1.2	71 37	.....	K2	8.44	6	
65 1233.....	18 1.3	65 57	7.64	F5	8.18	6	
63 1402.....	18 1.8	63 36	.....	Ao	8.15	5	
61 1718.....	18 3.0	61 33	.....	F5	8.85	5	
65 1240.....	18 5.1	65 42	7.70	Ao	6.97	6	S P.D.M.=7.36
65 1241.....	18 5.2	65 04	7.40	Ko	8.30	7	
66 1077.....	18 5.3	66 56	6.87	F5	7.58	6	
64 1245.....	18 6.2	64 12	6.81	Ko	7.69	6	
65 1245.....	18 6.9	65 52	7.72	A2	8.10	6	S P.D.M.=8.20
67 1051.....	18 8.0	67 24	7.72	Ko	8.79	4	
71 872.....	18 8.1	71 26	.....	K2	8.73	4	
61 1727.....	18 8.9	61 52	7.08	F8	7.69	4	
67 1052.....	18 9.3	67 58	7.97	Ao	8.00	4	S
71 876.....	18 9.6	71 03	.....	A2	8.73	5	
60 1813.....	18 9.9	60 23	6.32	Ao	6.43	4	S
67 1054.....	18 10.3	67 46	.....	Go	8.45	4	
60 1814.....	18 10.3	60 36	.....	F8	8.18	4	
72 829.....	18 10.6	72 08	.....	F5	7.92	6	
66 1087.....	18 11.7	66 06	7.34	Ko	8.35	6	
69 970.....	18 12.0	69 41	.....	Go	8.56	6	
64 1252.....	18 13.3	64 22	5.03	F5	5.63	7	
66 1089.....	18 13.8	66 27	.....	Fo	8.26	5	
64 1253.....	18 13.8	64 43	7.30	K2	8.52	3	
70 1087.....	18 15.5	70 48	7.06	A3	7.22	7	S
64 1256.....	18 15.6	64 02	.....	A2	8.29	4	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
68° 984.....	18 ^h 15 ^m 9	68° 43'	6.11	Ko	7.11	7	S
69 973.....	18 17.5	69 40	.....	F5	8.55	7
68 980.....	18 17.6	68 42	6.72	Ao	6.57	8	
69 974.....	18 18.9	69 58	7.69	F5	8.11	10	
64 1263.....	18 19.8	64 09	7.40	Ko	8.24	5	
67 1066.....	18 19.9	67 18	7.13	Ma	8.46	3	
65 1262.....	18 20.0	65 16	.....	F8	8.38	8
71 884.....	18 20.7	71 28	.....	F5	7.00	7
69 977.....	18 21.8	70 00	7.89	Go	8.11	7	
71 889.....	18 22.2	71 17	4.24	Aop	4.32	5	
62 1616.....	18 22.6	62 43	A2	8.37	5	
72 839.....	18 22.8	72 42	3.69	F8	4.44	5	
60 1827.....	18 24.7	60 25	.....	F2	8.61	5
64 1266.....	18 24.8	64 46	7.25	Ko	8.35	7	
65 1271.....	18 25.7	65 30	4.99	Ko	6.12	7	
70 908.....	18 26.9	70 21	Ao	8.13	6	
71 894.....	18 27.5	71 40	7.39	F5	7.67	7	
64 1270.....	18 29.4	65 00	8.30	A2	8.41	8	
68 1001.....	18 30.0	68 35	.....	F8	8.54	3
62 1629.....	18 30.4	62 28	7.02	F2	7.34	4	
65 1276.....	18 30.9	65 22	6.31	A3	6.80	7	S P.D.M. = 6.80
67 1079.....	18 32.6	67 42	6.81	K5	8.24	8	
68 1003.....	18 33.0	68 32	.....	G5	8.07	7
69 988.....	18 33.4	69 53	8.24	Ao	8.32	9	
66 1112.....	18 33.8	66 16	7.18	Ao	7.46	7	S P.D.M. = 7.76
68 1005.....	18 34.2	66 59	G5	8.55	4	S P.D.M. = 6.30
64 1276.....	18 35.8	64 59	8.30	Ao	8.48	4	
65 1283.....	18 35.9	65 24	6.00	A3	6.28	7	
72 852.....	18 36.1	72 20	7.34	Ko	8.27	6	
66 1117.....	18 36.4	66 50	7.58	Ko	8.25	8	
72 855.....	18 37.0	72 11	7.41	Ko	8.31	5	S
70 1012.....	18 37.1	70 22	7.64	Ko	8.40	5	
67 1085.....	18 37.2	67 43	7.36	Ao	7.53	9	
60 1840.....	18 37.2	60 37	6.59	F2	7.10	5	
72 857.....	18 37.7	72 18	6.93	K3	8.14	6	
63 1445.....	18 37.7	63 26	6.88	Ko	8.16	3	
73 831.....	18 37.9	73 12	7.45	G5	8.30	4	
67 1087.....	18 38.5	67 02	.....	G5	8.34	8
63 1446.....	18 38.6	63 41	.....	A3	8.50	2
62 1641.....	18 40.1	62 39	6.01	Ko	7.08	3	
72 859.....	18 41.0	72 53	K5	8.30	6	
74 789.....	18 41.2	74 32	.....	A5	8.35	2
60 1845.....	18 43.1	60 56	6.23	Ko	7.19	5	
62 1645.....	18 43.3	62 53	.....	A2	8.22	2
71 906.....	18 43.7	71 33	.....	G5	8.55	4

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
70° 1020.....	18 ^h 43 ^m 8	70° 29'	.....	Ao	7.64	13	
69 999.....	18 43.9	69 15	7.94	G5	8.39	9	
64 1289.....	18 44.1	64 42	7.30	Ko	8.39	4	
70 1023.....	18 44.3	70 41	6.56	K2	7.81	9	
63 1461.....	18 45.9	63 09	7.28	Ko	8.31	3	
68 1019.....	18 46.3	68 38	.....	Ao	7.77	7	
67 1096.....	18 47.0	67 40	7.00	Ao	7.00	8	
73 835.....	18 48.3	73 58	5.38	G5	6.13	4	
60 1852.....	18 49.0	60 43	6.78	K2	8.20	4	
68 1026.....	18 49.2	68 28	.....	F8	8.60	3	
61 1783.....	18 49.6	61 52	.....	A2	8.46	4	
74 792.....	18 49.7	74 36	7.72	Go	7.53	2	
66 1142.....	18 54.0	66 59	7.42	Ao	7.62	9	S P.D.M. = 7.78
74 796.....	18 54.4	74 20	.....	F2	8.35	3	
71 914.....	18 54.4	71 39	6.94	A2	7.00	7	S
73 843.....	18 55.6	73 58	.....	G5	8.33	4	
71 915.....	18 55.6	71 10	4.91	Ko	6.03	9	
65 1309.....	18 56.0	65 07	5.78	Ko	6.60	7	
62 1669.....	18 56.3	62 16	6.44	Ko	7.38	4	
68 1035.....	18 57.1	68 09	7.47	G5	8.30	9	
60 1864.....	18 57.3	60 32	6.69	Ao	6.87	6	
72 871.....	18 57.4	73 02	.....	A2	8.54	4	
62 1671.....	18 58.6	62 53	.....	A2	8.30	2	
69 1018.....	18 59.5	69 23	6.40	B9	6.13	10	S
70 1039.....	19 0.4	70 33	.....	Ko	8.40	5	
73 845.....	19 1.0	74 00	6.99	Fo	7.17	3	
68 1039.....	19 1.3	68 34	.....	Ao	8.41	6	
71 923.....	19 1.4	71 22	.....	Ao	8.44	7	
62 1674.....	19 1.6	62 33	7.03	Ko	7.98	6	
61 1808.....	19 2.4	61 57	7.02	G5	7.82	5	
68 1040.....	19 3.3	68 10	6.94	A2	7.18	10	S P.D.M. = 7.26
65 1319.....	19 3.0	65 26	7.15	Ko	8.32	6	
66 1154.....	19 3.7	66 16	.....	A3	8.32	6	
73 848.....	19 5.5	73 13	.....	Fo	7.99	4	
61 1817.....	19 5.9	61 08	.....	F2	8.48	4	
71 932.....	19 8.5	71 55	7.00	F8	7.67	7	
72 877.....	19 9.4	72 06	.....	A2	7.76	7	
65 1326.....	19 9.4	65 49	6.19	A2	6.27	6	S
71 934.....	19 9.7	71 20	.....	Ao	8.35	5	
68 1046.....	19 10.1	68 56	.....	K5	8.48	6	
73 853.....	19 10.2	73 28	.....	A2	8.50	4	
62 1691.....	19 10.4	63 02	.....	F8	8.42	2	
71 936.....	19 11.3	72 04	7.40	Fo	7.80	7	
69 1034.....	19 11.7	69 15	.....	A5	8.76	3	
71 938.....	19 11.8	71 56	.....	Ao	8.25	7	

CATALOGUE—Continued

B.D. No.	R A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
62° 1698.....	19 ^h 13 ^m 0	62° 37'	.....	Ao	8.29	4	
66 1179.....	19 13.6	66 56	6.81	A2	6.97	6	
65 1333.....	19 14.2	65 06	7.40	Ao	7.58	6	
73 854.....	19 14.5	73 43	.....	Ma	8.70	3	
65 1335.....	19 15.1	65 57	.....	F5	8.18	5	
62 1702.....	19 15.9	63 02	6.91	F5	7.55	4	
66 1184.....	19 16.2	66 58	.....	B5	7.74	7	
74 812.....	19 16.8	74 51	.....	Ko	8.35	2	
60 1926.....	19 16.8	60 46	7.01	B9	7.03	6	S
73 856.....	19 17.1	73 39	.....	Ao	8.10	4	
72 884.....	19 17.1	72 45	.....	A2	8.70	4	
73 857.....	19 17.5	73 10	4.63	Ko	5.77	4	
71 945.....	19 18.4	71 10	7.06	G5	7.78	7	
67 1142.....	19 18.5	67 28	.....	Ao	8.37	4	
64 1344.....	19 19.0	64 12	6.33	B9	6.28	7	S
74 815.....	19 19.7	74 44	.....	Ao	8.36	2	
63 1516.....	19 19.9	63 53	7.59	A5	8.15	6	S P.D.M.=7.98
65 1345.....	19 20.1	65 31	4.63	A2	4.94	6	S P.D.M.=4.80
74 816.....	19 20.3	74 07	.....	A2	8.21	2	
73 860.....	19 20.8	73 22	6.71	A5	7.09	8	S P.D.M.=7.21
71 949.....	19 22.1	71 55	7.16	Ko	8.20	7	
60 1943.....	19 22.7	60 09	7.76	Ko	8.76	4	
70 1058.....	19 22.8	70 24	8.19	Ao	8.22	7	
60 1944.....	19 22.8	61 00	7.81	K2	8.85	4	
68 1062.....	19 23.9	68 49	7.14	Ma	8.55	4	
71 951.....	19 24.2	71 42	.....	A5	8.46	5	
74 821.....	19 25.1	74 26	.....	B9	8.31	2	
62 1716.....	19 25.3	62 21	6.46	K5	8.04	4	
60 1959.....	19 28.0	60 28	7.51	K2	8.80	4	
73 863.....	19 28.7	73 09	7.69	F2	7.81	5	
67 1156.....	19 28.7	67 25	7.70	G5	8.37	6	
72 895.....	19 29.2	72 17	7.60	Ko	8.49	6	
60 1963.....	19 30.3	60 39	8.32	Go	8.73	4	
71 955.....	19 31.0	71 44	.....	Ao	8.33	4	
71 956.....	19 31.2	72 03	7.80	Ko	8.49	6	
69 1052.....	19 31.4	69 19	.....	Ko	8.47	7	
70 1073.....	19 31.8	70 46	6.25	K2	7.65	9	
61 1877.....	19 32.1	61 49	.....	Go	8.79	4	
69 1053.....	19 32.5	69 30	4.78	Ko	5.59	10	
62 1730.....	19 32.6	62 24	7.72	Ko	8.74	2	
71 960.....	19 33.2	71 07	.....	Ao	8.19	9	
74 828.....	19 33.5	74 33	.....	A5	8.28	2	
63 1539.....	19 33.7	63 13	6.64	K2	8.12	4	
71 964.....	19 35.4	71 23	6.71	F2	7.01	10	
60 1981.....	19 35.5	60 29	8.31	A5	8.84	7	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
63° 1544.....	19 ^h 36 ^m 7	63° 30'	.....	F2	8.51	3	
66 1225.....	19 39.1	66 14	.....	A2	8.22	6	
68 1077.....	19 39.2	68 25	6.90	G5	7.82	10	
62 1747.....	19 39.3	62 26	7.30	F5	7.94	3	
60 1998.....	19 40.7	60 19	.....	A2	8.44	8	
60 2005.....	19 42.7	60 26	.....	A3	8.68	8	
70 1073.....	19 42.9	70 43	.....	Fo	8.56	5	
69 1067.....	19 43.5	69 15	.....	Fo	8.36	8	
71 973.....	19 44.0	72 07	.....	Ao	8.18	6	
72 909.....	19 44.1	72 17	.....	A2	8.23	5	
68 1070.....	19 44.4	69 06	5.90	Ao	5.91	10	S
63 1561.....	19 44.9	63 16	8.04	F5	8.65	3	
67 1201.....	19 45.8	67 29	.....	Fo	8.01	9	
69 1069.....	19 46.3	69 40	.....	Ao	8.20	7	
68 1082.....	19 46.5	68 11	6.35	Fo	6.56	6	
72 911.....	19 48.0	72 13	7.43	Ko	8.31	6	
62 1759.....	19 48.2	62 57	6.83	Ko	8.34	5	
69 1070.....	19 48.5	70 01	3.99	Ko	5.04	8	
65 1406.....	19 48.5	65 42	.....	F8	8.38	2	
60 2026.....	19 48.8	60 57	6.69	F5	7.17	6	
60 2027.....	19 48.9	60 39	.....	A2	8.52	5	
60 2032.....	19 50.3	61 03	.....	A2	8.26	6	
65 1409.....	19 50.4	65 17	7.85	G5	8.58	2	
68 1084.....	19 50.5	68 21	.....	A3	8.42	5	
61 1932.....	19 50.8	61 43	.....	A2	8.64	6	
66 1253.....	19 52.0	66 26	7.58	Fo	7.92	7	
60 2045.....	19 53.1	60 33	7.34	K5	8.81	5	
60 2046.....	19 53.2	60 21	7.36	K5	8.90	5	
64 1398.....	19 53.8	64 27	6.93	G5	8.31	5	
62 1768.....	19 53.8	62 20	7.97	F2	8.40	2	
67 1211.....	19 54.2	67 15	.....	Ko	8.44	6	
66 1256.....	19 54.4	66 29	7.24	Ko	8.23	6	
62 1773.....	19 55.9	62 36	7.38	Fo	7.96	5	
60 2059.....	19 56.0	60 18	.....	Ao	8.49	6	
60 2060.....	19 56.3	60 34	7.36	G5	8.44	6	
63 1584.....	19 57.2	63 16	5.96	Ao	6.20	6	S P.D.M.=6.37
71 981.....	19 57.7	72 02	.....	Ko	8.38	8	
73 890.....	19 57.9	73 21	.....	F5	8.71	7	
72 926.....	19 57.9	72 40	.....	K5	8.36	9	
71 984.....	19 58.4	71 35	.....	A	8.60	5	
68 1096.....	19 58.4	68 08	7.48	A2	7.78	8	S P.D.M.=7.91
71 986.....	19 58.7	71 39	.....	Ko	8.52	4	
60 2070.....	19 58.7	60 48	8.00	A2	8.26	6	S P.D.M.=8.53
69 1084.....	19 59.0	70 05	6.46	G5	7.11	9	
69 1086.....	19 59.7	69 08	.....	Ao	7.54	8	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
68° 1097.....	19 ^h 59 ^m 8	68° 10'	7.92	B9	7.93	8	S
74 845.....	20 0 0	74 35	.....	F2	8.69	6	
64 1405.....	20 0 4	64 32	5.03	Ma	7.16	7	
71 991.....	20 1.1	71 37	7.90	K5	8.61	5	
64 1407.....	20 1.2	64 21	6.65	G5	7.24	6	
70 1102.....	20 1.8	70 11	8.09	B9	8.08	8	
67 1222.....	20 2.4	67 35	4.66	K3	5.90	9	
63 1593.....	20 3.5	63 36	6.18	A2	6.28	5	S
61 1970.....	20 4.0	61 42	5.57	K0	6.77	5	
67 1226.....	20 4.5	67 44	6.56	Ma	8.17	8	
70 1104.....	20 5.1	71 07	.....	A0	8.40	8	
63 1598.....	20 5.5	63 25	7.32	A0	7.77	5	S P.D.M. = 8.12
73 896.....	20 5.7	74 03	.....	F5	8.48	7	
72 933.....	20 5.8	72 44	.....	G	8.60	8	
72 934.....	20 5.8	72 29	7.70	A0	7.47	7	S
73 897.....	20 5.9	73 37	6.86	K0	7.83	7	
67 1227.....	20 6.0	68 00	.....	B9	8.52	5	
65 1433.....	20 6.2	66 01	6.89	A0	7.09	6	S P.D.M. = 7.22
64 1415.....	20 6.4	64 54	7.70	A5	7.95	4	S P.D.M. = 8.00
73 898.....	20 6.5	73 10	.....	Ma	8.58	4	
70 1105.....	20 6.7	70 21	7.79	F0	8.11	11	
64 1417.....	20 6.7	64 52	7.90	A5	8.23	4	
61 1975.....	20 7.4	61 47	6.57	A0	6.72	4	S P.D.M. = 6.92
59 2185.....	20 7.7	60 07	7.91	F0	8.32	4	
63 1601.....	20 7.9	63 46	.....	A0	8.47	2	
68 1110.....	20 9.0	68 18	7.02	K0	8.37	3	
70 1106.....	20 9.3	70 28	8.19	K0	8.34	10	
61 1983.....	20 9.9	61 47	5.72	F5	6.03	5	
63 1605.....	20 10.2	63 14	.....	B9	7.82	3	
67 1235.....	20 10.5	67 58	6.79	B3	6.88	9	
73 900.....	20 10.8	74 08	.....	F5	8.57	4	
60 2099.....	20 11.6	20 60	6.16	K2	7.47	6	
72 941.....	20 11.9	72 22	.....	K0	8.66	5	
71 1007.....	20 12.0	71 41	.....	F5	8.37	10	
73 901.....	20 13.0	73 41	.....	A0	8.28	7	
64 1427.....	20 13.0	64 27	7.25	G5	8.26	6	
70 1111.....	20 13.6	70 48	.....	F0	8.00	12	
72 943.....	20 14.2	72 34	7.11	F0	7.36	9	
65 1443.....	20 14.7	65 33	7.65	F5	8.25	6	
72 945.....	20 15.7	72 18	7.34	Ma	8.50	7	
71 1011.....	20 15.8	71 50	.....	A2	8.48	10	
66 1281.....	20 16.5	66 32	6.08	F8	6.47	8	
60 2109.....	20 17.1	60 18	7.81	B8	7.84	6	
72 946.....	20 17.9	72 34	.....	F5	8.60	7	
61 2000.....	20 18.0	61 56	5.61	B9	5.57	6	S

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
71° 1014.....	20 ^h 18 ^m 1	71° 27'	A3	8.41	9	S P.D.M. = 7.46
70 1115.....	20 18.3	70 28	7.24	A5	7.42	11	
60 2117.....	20 19.1	60 44	.....	A2	8.41	7
68 1121.....	20 19.6	68 34	5.99	Mb	7.44	10	
63 1618.....	20 19.8	63 40	5.92	K5	7.52	5	
74 858.....	20 21.6	74 16	Go	8.77	3	
69 1099.....	20 21.9	69 11	.....	A3	7.38	10
59 2227.....	20 22.9	60 01	8.11	Ao	8.19	3	
72 950.....	20 23.1	72 54	.....	A5	8.44	10
72 949.....	20 23.2	72 50	.....	Fo	8.34	10
60 2125.....	20 23.2	60 59	A2	8.13	6	
61 2012.....	20 24.1	61 15	.....	Go	8.58	5
68 1126.....	20 25.7	69 00	7.30	G5	8.16	10	
74 863.....	20 26.3	74 47	.....	Ao	8.68	3
65 1422.....	20 26.7	65 25	6.62	A2	6.65	6	
68 1129.....	20 26.8	68 27	7.24	G5	8.11	8	S
59 2246.....	20 27.3	60 05	7.36	Ao	7.67	3	
72 953.....	20 27.4	72 30	.....	A2	8.64	8
61 2026.....	20 29.9	62 07	.....	Ao	7.71	2
59 2257.....	20 30.0	60 06	7.11	F2	7.58	3	
72 957.....	20 30.4	72 12	6.42	K2	7.60	11	Var.?
64 1449.....	20 30.9	65 34	6.79	Ko	7.84	7	
61 2028.....	20 32.1	60 25	6.90	Ao	6.97	3	
70 1126.....	20 32.2	70 11	6.72	Ao	6.45	8	
74 872.....	20 32.8	74 37	5.18	A2p	5.16	7	
61 2031.....	20 33.2	61 41	B9	8.64	4	S P.D.M. = 5.34
61 2032.....	20 33.3	62 07	.....	Ko	8.56	4
61 2037.....	20 34.6	61 39	.....	Ao	7.57	4
69 1057.....	20 34.8	70 02	7.69	Ao	7.81	7	
61 2039.....	20 34.9	62 05	.....	Fo	8.10	4
69 1114.....	20 35.0	69 20	6.89	G5	7.66	12	
60 2131.....	20 35.2	61 00	6.93	F2	7.24	4	
60 2142.....	20 35.7	60 24	7.06	Go	7.94	4	
60 2143.....	20 35.8	60 45	.....	A2	8.46	4
66 1311.....	20 36.1	67 09	7.35	B9	7.56	9	
60 2145.....	20 36.4	60 33	F8	8.51	4	S P.D.M. = 8.00
59 2272.....	20 38.2	60 09	5.95	F5	6.31	4	
74 877.....	20 39.8	74 54	.....	A2	8.66	5
60 2154.....	20 40.5	60 14	6.11	Ao	6.13	4	
62 1850.....	20 40.6	63 00	.....	B8	7.56	4
62 1852.....	20 40.9	62 51	Ao	7.38	5	S P.D.M. = 6.36
71 1027.....	20 41.1	71 30	.....	A2	8.55	9
74 878.....	20 41.4	74 39	.....	Ao	8.90	5
65 1499.....	20 41.5	65 58	6.92	B9	6.97	6	
72 962.....	20 41.7	72 37	7.34	K2	8.44	10	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
66° 1318.....	20 ^h 41 ^m 09	66° 18'	5.57	A5	5.80	6	S
61 2050.....	20 43.3	61 27	3.59	K0	5.20	3	
63 1655.....	20 43.5	63 11	.....	A5	7.60	3
61 2051.....	20 43.6	62 02	.....	B0	7.83	4
69 1127.....	20 43.9	69 23	6.52	K0	7.51	8	
63 1660.....	20 45.1	63 37	F0	7.92	4	S
66 1326.....	20 45.4	66 54	.....	B9	8.32	6
71 1029.....	20 45.7	71 24	.....	G0	8.92	5
74 886.....	20 46.0	74 20	.....	G0	8.95	8
69 1129.....	20 46.0	69 34	7.75	A0	7.82	10	
60 2169.....	20 46.8	60 46	F8	8.28	4	S
67 1267.....	20 47.3	67 39	6.94	F0	7.24	8	
61 2057.....	20 47.3	62 09	.....	B8	7.84	4
68 1157.....	20 47.5	68 46	.....	G0	8.34	6
63 1663.....	20 47.5	63 40	6.38	B0	6.39	5	
61 2059.....	20 47.6	61 59	A0	8.06	4	S
69 1130.....	20 47.8	69 17	7.42	A0	7.54	12	
61 2062.....	20 48.3	62 01	.....	A0	8.20	4
63 1667.....	20 48.6	63 28	.....	F0	8.23	4
71 1033.....	20 49.2	71 24	.....	G5	8.83	5
63 1669.....	20 49.8	63 24	A2	8.40	2	P.D.M. = 8.61
60 2173.....	20 50.6	60 19	.....	F2	8.59	4
72 907.....	20 51.4	72 34	8.02	F8	8.49	8	
61 2070.....	20 51.6	61 23	7.18	F0	7.39	4	
72 968.....	20 51.9	72 42	8.12	A2	8.26	7	
74 889.....	20 52.4	74 23	G5	8.45	6	S P.D.M. = 8.55
74 890.....	20 52.6	74 16	7.39	A3	7.35	6	
69 1136.....	20 53.6	69 34	7.80	K0	8.56	3	
65 1518.....	20 53.9	65 18	7.25	B9	7.26	8	
60 2179.....	20 54.7	61 10	.....	F5	8.31	4
62 1878.....	20 55.3	62 27	A0	8.02	3	S P.D.M. = 8.51
60 2181.....	20 55.4	60 57	.....	G5	8.26	4
68 1170.....	20 56.2	68 40	7.07	K2	8.16	7	
61 2078.....	20 57.6	61 28	.....	A2	8.32	3
71 2037.....	20 58.5	71 56	8.19	A2	8.33	9	
70 1156.....	20 58.8	70 34	8.04	A2	8.20	10	S P.D.M. = 7.60 S P.D.M. = 7.59
74 898.....	21 0.1	74 32	.....	G0	8.93	5
73 922.....	21 0.1	73 53	7.99	K0	8.96	5	
67 1283.....	21 0.4	67 46	7.20	B5	7.34	8	
62 1889.....	21 2.1	62 50	7.26	A5	7.66	5	
64 1496.....	21 2.6	64 37	A0	8.34	6	S P.D.M. = 7.60 S P.D.M. = 7.59
61 2090.....	21 2.6	61 30	.....	A2	8.26	3
70 1159.....	21 3.2	70 55	.....	A0	7.68	10
61 2092.....	21 3.3	61 47	7.58	A0	7.60	4	
62 1892.....	21 3.9	62 31	7.06	K5	8.44	4	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
70° 1162.....	21 ^h 4 ^m 0	70° 25'	.....	Ao	8.55	6	
70 1164.....	21 5.8	71 02	5.96	F2	6.09	10	
67 1288.....	21 6.3	67 51	6.80	A2	6.86	8	
62 1900.....	21 6.8	62 30	.....	Ao	8.33	4	
71 1046.....	21 7.0	71 16	.....	F2	8.30	8	
62 1903.....	21 7.3	62 53	6.50	B8	6.28	4	S
65 1552.....	21 8.3	65 17	7.75	B9	7.73	6	S
65 2554.....	21 8.9	65 45	7.25	Ko	8.35	3	
66 1366.....	21 9.2	66 08	7.37	Ko	8.37	3	
74 907.....	21 10.1	74 50	6.96	F5	7.37	4	
70 1170.....	21 10.3	70 59	.....	Ao	8.77	7	
70 1171.....	21 10.7	70 25	7.59	A3	7.69	10	S
69 1171.....	21 10.7	70 02	7.10	K2	8.14	7	
72 926.....	21 11.2	73 39	.....	Ao	9.17	4	
63 1708.....	21 11.7	64 00	6.41	Go	6.92	4	
71 1054.....	21 11.8	72 03	.....	F5	8.77	6	
67 1295.....	21 11.9	67 44	8.28	Ao	8.40	3	
69 7397.....	21 12.6	73 52	.....	Ao	9.10	4	
69 1152.....	21 12.7	69 37	6.80	Ko	7.50	10	
64 1515.....	21 12.7	64 20	6.92	Ko	8.01	5	
65 1565.....	21 13.8	65 27	8.35	Fo	8.40	2	
72 980.....	21 14.0	72 45	7.55	A2	7.66	7	
72 981.....	21 14.1	72 59	.....	Ko	8.91	4	
74 911.....	21 14.4	74 24	.....	F2	8.79	5	
68 1195.....	21 14.6	68 29	.....	A	8.44	2	
74 912.....	21 15.6	74 12	.....	F2	8.79	5	
60 2217.....	21 16.0	60 45	6.80	Mb	8.18	4	
72 982.....	21 16.1	73 05	.....	Ao	9.02	5	
70 1176.....	21 16.1	71 07	.....	A3	9.11	3	
65 1574.....	21 17.0	64 34	7.60	Ko	8.23	3	
71 1058.....	21 17.1	71 44	.....	F5	8.91	5	
64 1527.....	21 17.3	64 27	5.18	B3p	5.19	5	
60 2226.....	21 17.8	60 42	.....	Ao	8.16	4	
60 2224.....	21 17.8	60 15	6.74	F5	7.10	5	
64 1528.....	21 18.0	64 12	8.20	Ao	8.09	5	
60 2227.....	21 18.0	60 21	6.24	Ko	7.09	5	
61 2118.....	21 18.2	62 06	.....	F8	8.21	3	
68 1206.....	21 18.8	69 07	.....	A5	7.78	8	
59 2362.....	21 19.0	60 09	7.61	F5	7.68	5	
72 984.....	21 20.2	72 45	7.55	A2	7.66	7	S
63 1721.....	21 20.4	63 48	.....	Ko	8.52	4	
71 1062.....	21 21.2	71 38	7.02	Ao	7.07	10	S
64 1535.....	21 21.2	64 34	7.38	B9	7.59	7	S
64 1536.....	21 21.3	64 36	7.08	B9	7.13	6	S Var.?
60 2233.....	21 21.6	60 23	7.61	B3	7.33	5	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
60° 2234.....	21 ^h 21 ^m 8	60° 51'	.....	Go	8.36	5	
61 2131.....	21 22.0	61 17	.....	Ko	8.61	4	
68 1206.....	21 22.4	69 06	7.03	B8	6.76	9	S
69 1166.....	21 23.1	69 34	7.71	Ao	7.64	8	S
64 1546.....	21 23.9	64 50	8.15	F8	8.39	5	
62 1942.....	21 24.6	63 09	7.52	Ao	7.71	4	S P.D.M. = 7.94
61 2136.....	21 24.8	61 39	7.56	Ko	8.34	4	
61 2139.....	21 25.5	61 40	6.89	Ko	7.63	4	
66 1404.....	21 25.7	66 13	.....	F2	8.08	6	
66 1405.....	21 25.8	66 22	5.42	B5	5.04	4	S
60 2254.....	21 26.5	61 00	7.11	F5	7.35	4	
66 1407.....	21 27.4	66 37	6.90	A2	6.83	7	S
61 2148.....	21 28.0	61 28	.....	B9	7.66	4	
63 1741.....	21 28.3	63 52	8.10	A2	8.27	4	S
59 2395.....	21 28.3	60 01	5.52	Bo	5.36	4	
67 1322.....	21 28.9	67 51	7.06	B9	6.91	7	S
71 1072.....	21 29.2	71 15	.....	Ao	8.33	9	
70 1182.....	21 29.5	70 34	8.19	Ao	8.12	10	
69 1178.....	21 30.3	69 12	.....	A2	8.10	9	
64 1564.....	21 30.4	65 04	8.65	Ao	8.39	3	
73 936.....	21 30.5	73 13	.....	Ao	8.46	7	
72 992.....	21 30.9	72 38	.....	A2	9.01	4	
68 1225.....	21 31.0	68 20	.....	A2	8.23	4	
61 2155.....	21 31.3	61 21	.....	A2	7.77	3	
66 1412.....	21 31.4	66 47	.....	F8	8.30	2	
63 1747.....	21 31.7	63 18	7.38	A2	7.48	4	S
63 1748.....	21 31.8	63 34	.....	Ao	7.98	4	
65 1602.....	21 31.9	65 18	7.75	Ao	7.89	6	S P.D.M. = 8.13
61 2158.....	21 31.9	61 51	.....	B9	8.36	3	
72 993.....	21 32.4	72 31	.....	F2	8.41	9	
66 1415.....	21 32.4	66 17	7.01	Ko	8.17	5	
65 1602.....	21 33.0	65 08	7.93	Ao	7.88	6	
67 1329.....	21 33.6	67 46	7.52	B9	6.26	7	S P.D.M. = 6.78
63 1743.....	21 33.7	63 15	7.81	Ao	7.99	4	S P.D.M. = 8.09
61 2166.....	21 34.6	61 52	.....	Ko	7.96	4	
60 2271.....	21 34.6	60 38	8.06	A2	8.08	4	S
61 2169.....	21 35.2	61 38	4.87	B2p	4.90	4	
60 2276.....	21 36.3	61 06	.....	Oe5	8.28	4	
74 926.....	21 37.2	74 46	7.92	Ao	8.20	4	S P.D.M. = 8.24
70 1190.....	21 37.8	70 51	7.14	F5	7.36	10	
67 1340.....	21 37.9	67 40	.....	A2	8.20	2	
70 1191.....	21 38.2	70 59	.....	A2	8.25	9	
67 1343.....	21 38.3	67 55	.....	Ao	8.26	4	
70 1192.....	21 39.0	70 20	7.44	K5	8.22	7	
69 1191.....	21 39.6	69 14	.....	Ao	7.83	8	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
65° 1634.....	21 ^h 40 ^m 1	65° 54'	.....	Ao	8.03	4	
63 1764.....	21 40.1	63 16	7.01	F5	7.27	4	
61 2185.....	21 40.3	61 33	.....	Ao	8.04	5	
70 1193.....	21 40.4	70 51	4.85	Ko	5.80	10	
63 1768.....	21 40.5	63 45	.....	Fo	8.32	5	
60 2285.....	21 41.4	60 25	7.46	G5	8.15	5	
71 1082.....	21 41.9	71 52	5.40	Ko	6.20	11	
60 2288.....	21 42.6	60 40	4.46	A2p	4.84	4	S
71 1085.....	21 42.8	71 35	.....	F2	8.61	7	
61 2194.....	21 42.9	61 50	.....	B2	7.32	5	
67 1357.....	21 43.3	67 17	.....	B9	8.13	8	
65 1647.....	21 43.7	65 28	.....	A2	8.26	3	
71 1087.....	21 44.1	71 42	7.32	B9	7.53	8	S
69 1195.....	21 44.2	69 52	.....	G5	8.38	4	
60 2294.....	21 44.5	60 14	5.64	Ma	7.14	4	
69 1198.....	21 45.2	69 41	6.42	Ao	6.31	8	S
64 1594.....	21 45.7	64 42	6.98	Ko	8.03	6	
60 2300.....	21 46.4	60 49	6.41	Ma	7.93	4	
66 1441.....	21 46.8	66 20	6.51	F2	6.71	6	
60 2303.....	21 48.0	61 09	7.13	A2	7.35	4	S P.D.M.=7.93
63 1779.....	21 48.4	63 32	.....	B9	7.40	4	
71 1092.....	21 48.7	71 17	.....	Go	8.45	6	
71 1093.....	21 48.9	71 31	.....	A5	8.80	3	
64 1599.....	21 48.9	64 15	.....	Ko	8.35	4	
61 2209.....	21 48.9	61 27	.....	B3	8.11	4	
64 1600.....	21 49.2	64 26	7.01	Ko	7.81	5	
62 1992.....	21 49.5	62 38	.....	B3	7.40	4	
62 1994.....	21 49.7	62 14	6.76	B1	6.77	2	
71 1095.....	21 50.0	71 25	.....	A2	8.42	4	
59 2430.....	21 50.0	60 10	8.11	B5	8.07	4	
71 1096.....	21 50.8	72 01	7.16	B9	7.11	9	
70 1204.....	21 50.8	71 08	8.11	B9	8.12	10	S P.D.M.=8.45
67 1371.....	21 50.9	68 02	7.40	Ao	7.36	7	S
63 1784.....	21 51.1	63 16	.....	Ao	7.66	4	
69 1204.....	21 51.2	69 14	7.36	A2	7.38	8	
72 1003.....	21 51.6	73 14	6.58	Ao	6.70	7	
71 1097.....	21 51.7	71 31	7.01	B9	6.80	10	
61 2221.....	21 52.1	61 31	.....	Ko	7.96	4	
60 2318.....	21 52.3	61 04	6.22	K5	7.77	4	
67 1375.....	21 52.4	67 17	7.02	Fo	7.18	6	
64 1604.....	21 52.4	64 32	.....	Ao	8.10	4	
65 1680.....	21 52.7	65 15	7.15	Ao	7.11	6	
64 1607.....	21 52.9	64 51	5.85	B2	5.64	5	
66 1455.....	21 53.1	66 13	7.87	Fo	8.05	5	
62 2004.....	21 53.1	62 47	7.12	F5	7.80	4	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
62° 2006.....	21 ^h 53 ^m 4	62° 25'	.....	B5	7.42	4	
62 2007.....	21 53.8	62 09	5.35	Map	6.78	4	
64 1611.....	21 54.3	65 09	7.60	B3	7.26	5	
60 2320.....	21 54.3	61 49	6.90	B3	6.74	5	
65 1690.....	21 54.4	65 33	7.48	G5	7.77	3	
66 1463.....	21 55.2	66 39	.....	A	8.30	2	
62 2010.....	21 56.0	62 13	6.16	Mb	7.76	4	
60 2323.....	21 56.0	61 11	.....	A3	7.27	5	
62 2012.....	21 56.2	62 47	.....	B8	8.23	4	
63 1794.....	21 56.3	63 31	.....	B8	8.12	4	
74 946.....	21 56.9	74 31	6.64	K5	8.19	5	
67 1382.....	21 57.4	67 30	7.92	F5	8.19	5	
61 2233.....	21 57.6	62 00	6.48	Bo	6.33	4	
72 1009.....	21 57.8	72 42	5.15	F5	5.71	8	
61 2234.....	21 58.3	61 29	7.12	K2	8.03	5	
65 1704.....	21 58.4	65 36	.....	B8	8.02	6	
60 2329.....	21 58.4	61 04	.....	B8	7.79	5	
60 2330.....	21 59.2	60 37	.....	Ao	7.66	5	
65 1708.....	21 59.5	65 21	8.10	Ao	8.03	7	
74 947.....	21 59.6	74 35	.....	Ao	8.87	3	
64 1617.....	21 59.6	65 01	.....	Ao	8.38	2	
65 1712.....	22 0.1	65 35	6.76	B8	6.67	6	S
71 1104.....	22 0.7	71 34	.....	G5	8.69	4	
67 2028.....	22 0.9	62 38	5.46	Mb	6.88	4	
74 951.....	22 1.2	74 52	.....	G5	8.62	3	
71 1105.....	22 1.2	72 12	.....	Ko	8.90	3	
73 957.....	22 1.5	73 20	.....	K2	8.47	4	
60 2334.....	22 1.6	60 51	7.21	A2	7.15	5	S
62 2029.....	22 2.0	62 18	5.39	K5	6.69	3	
61 2246.....	22 2.1	61 48	5.17	Oe5	5.03	3	
62 2032.....	22 2.3	63 06	.....	G5	7.65	6	
67 1402.....	22 4.7	67 49	7.48	F2	7.69	7	
69 1219.....	22 4.8	69 44	.....	Ao	8.30	5	
71 1107.....	22 4.9	71 44	7.60	K2	8.37	5	
63 1807.....	22 5.0	63 15	.....	B5	8.01	6	
69 1221.....	22 5.1	70 12	7.00	Ao	7.03	6	S
71 1109.....	22 5.3	71 53	7.00	Ao	6.84	7	S
62 2039.....	22 5.4	62 14	.....	Ao	7.59	3	
74 952.....	22 5.6	74 58	.....	Go	8.89	3	
67 1405.....	22 5.6	68 02	.....	F5	8.21	8	
60 2348.....	22 5.6	60 30	7.26	B8	7.17	3	S
72 1016.....	22 6.0	71 27	.....	K2	9.02	2	
67 1409.....	22 6.4	67 14	.....	Ao	6.79	9	
69 1226.....	22 6.7	69 45	.....	F2	8.10	6	
63 1815.....	22 6.8	63 38	7.07	A2	7.13	5	P.D.M. = 7.16

CATALOGUE—Continued

B.D. No.	R A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
63° 1818.....	22 ^h 7 ^m 4	63° 52'	.....	Ao	7.14	5	
65 1728.....	22 7.5	65 49	.....	Ao	7.90	5	
64 1634.....	22 7.6	65 01	7.55	Ao	7.58	6	
71 1111.....	22 7.9	71 51	4.99	G5	5.87	7	
71 1112.....	22 8.3	71 37	6.36	B9	6.23	8	
69 1228.....	22 8.4	69 38	5.54	F2	5.97	5	
70 1221.....	22 [*] 8.5	70 39	7.64	Go	8.02	8	
60 2358.....	22 8.7	60 16	5.52	Ko	6.55	3	
70 1222.....	22 8.8	70 28	7.84	A2	7.99	6	
68 1286.....	22 8.8	68 22	.....	Ao	7.86	6	
69 1229.....	22 9.1	69 53	8.34	Fo	8.34	6	
63 1820.....	22 9.2	63 13	.....	Ao	7.83	5	
62 2048.....	22 9.3	62 48	6.06	Ma	7.26	5	
68 1287.....	22 10.4	68 29	7.32	Ao	7.16	6	S
72 1022.....	22 11.1	72 49	6.11	G5	6.92	7	
69 1232.....	22 11.2	69 39	.....	Ao	8.10	6	
66 1490.....	22 11.3	66 26	.....	Ao	8.24	4	
71 1116.....	22 11.9	71 58	.....	Ko	8.60	6	
63 1823.....	22 12.8	63 43	.....	Ao	8.26	5	
61 2272.....	22 13.1	61 49	7.00	A3	7.05	3	S
62 2056.....	22 13.4	63 13	7.38	G5	8.27	5	
65 1746.....	22 14.3	65 38	7.00	Ao	7.02	7	S
72 1025.....	22 14.4	73 06	.....	F2	8.55	4	
69 1237.....	22 14.4	69 25	.....	Ao	8.25	6	
62 2059.....	22 14.9	62 18	5.99	K5	7.03	4	
60 1238.....	22 15.1	69 34	7.48	Ko	8.32	5	
68 1295.....	22 17.9	68 52	.....	F5	8.02	6	
64 1649.....	22 17.9	64 49	7.95	A2	8.13	8	
66 1501.....	22 18.0	66 28	7.26	A5	7.36	8	S
70 1231.....	22 18.3	71 11	.....	A2	8.25	6	
62 2070.....	22 19.1	62 38	6.86	Ao	6.87	6	S
69 1245.....	22 19.2	69 46	7.84	Ao	7.93	7	
68 1298.....	22 19.6	69 09	.....	A2	8.14	5	
61 2291.....	22 19.6	61 55	6.01	Ao	6.05	3	S P.D.M.=6.24
71 1127.....	22 20.3	71 40	.....	A3	8.78	5	
74 963.....	22 21.1	74 30	.....	Ko	8.83	3	
60 2393.....	22 21.7	60 19	7.96	Ao	7.93	2	
70 1234.....	22 21.8	70 48	7.52	A3	7.58	7	
70 1236.....	22 22.0	70 32	7.44	A3	7.37	6	
72 1036.....	22 23.3	73 06	.....	Fo	8.33	6	
70 1240.....	22 23.4	70 16	5.69	Ko	6.63	7	
68 1303.....	22 23.4	68 32	.....	Fo	7.26	6	
61 2297.....	22 23.7	61 25	6.66	Ko	7.58	3	
64 1665.....	22 23.9	64 57	.....	G5	7.87	6	
64 1664.....	22 23.9	64 37	5.66	Bo	5.81	6	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
63° 1850.....	22 ^h 24 ^m 0	63° 27'	.....	Ao	7.28	5	
62 2084.....	22 24.1	62 45	.....	Ao	7.86	5	
72 1037.....	22 24.7	73 04	.....	Ao	7.75	7	
63 1852.....	22 25.0	63 34	6.38	Ko	7.49	5	
60 2397.....	22 25.2	60 57	7.47	Ko	8.05	2	
70 1243.....	22 25.3	70 18	7.74	Ao	7.66	7	
61 2303.....	22 25.6	61 15	.....	Ao	8.19	3	
64 1672.....	22 26.0	64 36	.....	Bo	7.99	6	
65 1774.....	22 26.6	65 58	.....	B8	8.24	5	
69 1256.....	22 26.8	69 55	7.24	A2	7.34	8	S P.D.M.=7.43
60 2403.....	22 27.0	61 07	.....	Ao	8.19	3	
69 1257.....	22 27.2	69 40	7.16	B5	6.87	8	
63 1857.....	22 27.9	63 18	7.40	G5	8.12	4	
61 2312.....	22 29.4	61 26	.....	Ao	8.33	3	
69 1262.....	22 30.1	69 24	6.02	A5	6.26	8	Var.?
67 1450.....	22 30.1	67 59	7.61	A3	7.71	8	S
61 2314.....	22 30.3	61 16	6.51	A2	6.61	3	S
60 1263.....	22 30.4	60 51	6.26	Ao	6.24	8	S
65 1782.....	22 30.6	65 19	7.65	Ko	8.23	6	
64 1682.....	22 30.6	64 42	7.75	B9	7.77	7	S P.D.M.=8.07
73 982.....	22 30.7	73 33	7.20	K2	8.40	5	
60 2414.....	22 31.4	60 18	7.06	F2	7.35	2	
65 1784.....	22 31.7	65 49	.....	F2	8.17	5	
66 1527.....	22 31.9	67 12	.....	Ao	8.28	8	
69 1269.....	22 32.8	69 44	7.25	Ko	8.09	7	
68 1316.....	22 33.1	68 33	.....	A3	8.26	7	
72 1049.....	22 33.3	73 07	5.22	Fo	5.77	7	
72 1650.....	22 33.6	72 22	7.46	F5	7.48	7	
63 1872.....	22 34.1	63 15	7.06	Ko	7.64	5	
59 1552.....	22 34.4	60 07	8.71	Ao	8.59	3	
65 1780.....	22 34.8	65 37	7.25	Ao	7.28	5	S
74 978.....	22 35.1	74 51	6.06	K5	7.63	3	
62 2102.....	22 35.1	63 04	5.21	A2	5.26	3	S P.D.M.=5.40
73 985.....	22 36.0	73 59	.....	Ko	8.53	6	
66 1535.....	22 36.9	66 37	.....	A	8.58	3	
61 2328.....	22 37.1	61 32	.....	Ao	8.36	3	
65 1796.....	22 37.9	65 59	7.46	G5	7.84	7	
72 1055.....	22 38.8	72 44	7.68	Ao	7.55	7	S
64 1701.....	22 38.8	64 21	7.35	F8	8.18	4	
64 1702.....	22 39.2	65 09	7.80	Ao	7.61	7	S
64 1704.....	22 39.6	64 49	6.76	B2	6.62	6	
61 2336.....	22 39.7	62 09	6.89	G5	7.55	3	
73 989.....	22 40.1	73 48	7.90	F2	8.19	5	
66 1539.....	22 40.1	67 13	.....	A2	8.32	6	
60 2430.....	22 40.4	60 59	7.77	K2	8.56	2	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
63° 1882.....	22 ^h 40 ^m 5	64° 03'	Go	8.00	5	S
60 2433.....	22 41.1	60 18	8.11	B8	7.91	2	
67 1463.....	22 41.7	67 36	.....	A2	8.26	7
59 2568.....	22 43.0	60 06	8.76	A2	8.64	2	
64 1717.....	22 44.3	64 32	6.83	B3	6.91	6	P.D.M. = 6.98
70 1272.....	22 44.4	71 01	Fo	8.37	8	
62 2115.....	22 45.0	62 25	6.16	Ko	7.23	4	
60 2441.....	22 45.0	60 37	8.11	Ko	8.46	2	
73 996.....	22 45.6	74 08	8.43	A2	8.37	4	
62 2117.....	22 45.6	63 11	A3	8.22	5	
65 1813.....	22 46.1	66 02	6.97	B9	6.86	8	
71 1165.....	22 47.0	71 37	.....	A2	8.23	8
65 1817.....	22 47.2	66 12	7.30	K2	8.20	9	
74 988.....	22 47.3	74 38	.....	Ao	7.69	3
71 1166.....	22 47.3	72 04	Go	8.30	8	
60 2450.....	22 47.4	61 10	5.80	Go	6.42	2	
62 2121.....	22 47.7	62 27	6.84	G5	7.29	4	
61 2356.....	22 48.6	62 54	.....	B3	7.80	2
60 2453.....	22 48.9	60 22	7.56	Ao	7.80	2	
65 1826.....	22 49.3	66 05	A2	7.80	10	
60 2456.....	22 50.1	60 19	8.56	A3	8.34	2	
63 1904.....	22 50.6	63 35	.....	Go	8.08	4
60 2458.....	22 51.1	61 04	.....	A5	8.31	2
73 998.....	22 51.3	74 04	7.58	F5	7.83	7	
69 1288.....	22 52.0	69 46	7.64	A5	7.56	9	S
67 1481.....	22 52.1	68 68	Go	8.37	9	
61 2371.....	22 52.1	61 54	7.06	K5	8.12	2	
71 1172.....	22 52.3	72 04	.....	F5	8.19	9
67 1482.....	22 52.4	67 43	7.96	B8	7.89	9	
62 2136.....	22 52.6	62 19	7.76	B5	7.76	2	S
61 2373.....	22 52.9	62 12	7.70	Bo	7.83	2	
66 1565.....	22 53.2	66 47	.....	F5	8.45	7
61 2374.....	22 53.6	61 49	.....	A2	8.32	2
67 1485.....	22 54.2	67 52	.....	B8	8.12	10
62 2146.....	22 54.6	63 10	7.36	B5	7.36	4	
72 1079.....	22 54.7	72 36	6.64	Ko	7.66	7	
66 1569.....	22 54.7	66 33	.....	Go	8.31	3
62 2147.....	22 54.8	62 32	.....	B8	7.46	3
69 1292.....	22 55.6	70 13	8.54	A2	8.30	9	
71 1177.....	22 56.2	72 11	F5	8.09	9	
67 1490.....	22 56.2	67 25	Ao	7.66	8	
61 2384.....	22 58.1	61 58	.....	A5	8.07	5
63 1917.....	22 58.4	63 40	8.16	G5	8.43	2	
62 2160.....	22 58.6	62 48	7.00	Ko	8.05	3	
71 1181.....	22 58.9	72 12	Ao	7.97	9	

CATALOGUE—Continued

B.D. No.	R A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
63° 1920.....	22 ^h 59 ^m 0	63° 41'	.....	Ao	8.37	2	
62 2161.....	22 59.0	63 10	.....	B	8.24	2	
61 2385.....	22 59.3	62 06	.....	Ao	7.86	5	
62 2162.....	22 59.4	63 01	.....	B3	8.22	3	
60 2473.....	22 59.4	60 56	.....	Ao	7.90	6	
66 1575.....	22 59.7	66 40	5.50	Ko	6.61	9	
62 2163.....	23 0.0	62 51	.....	B5	7.66	3	
62 2165.....	23 0.5	62 42	6.78	Ko	7.58	3	
69 1303.....	23 0.7	70 06	8.24	Go	8.18	9	
63 1925.....	23 0.8	63 33	7.60	Fo	7.71	4	
67 1498.....	23 1.1	67 52	7.50	Go	7.93	8	
74 1001.....	23 1.2	74 59	.....	Ao	7.81	4	
61 2388.....	23 1.3	61 50	.....	A	8.03	6	
62 2170.....	23 2.1	62 40	7.46	B5	7.44	2	S
60 2479.....	23 2.4	60 55	6.74	F5	6.95	6	
60 2482.....	23 3.0	60 18	7.61	A2	7.60	6	S
69 1307.....	23 3.7	70 09	7.64	Ko	8.25	10	
64 1758.....	23 3.7	65 05	6.83	A2	6.97	5	S
62 2171.....	23 3.7	63 06	6.19	B3	6.22	2	
63 1931.....	23 3.9	63 41	6.41	Ko	7.27	4	
74 1006.....	23 4.7	74 51	4.56	G5	5.70	4	
62 2174.....	23 4.8	62 22	7.15	K2	7.95	2	
65 1850.....	23 5.0	65 32	7.90	A3	7.80	5	
63 1938.....	23 5.0	63 28	.....	Ao	7.82	3	
64 1764.....	23 5.2	64 20	6.62	B5	6.36	5	S
60 2491.....	23 5.2	61 07	.....	A	7.77	6	
67 1503.....	23 5.6	67 54	.....	B9	8.00	8	
66 1587.....	23 6.0	66 42	6.68	Ao	6.68	9	S
67 1504.....	23 6.1	68 06	.....	Ao	7.92	9	
63 1941.....	23 6.3	63 59	7.12	F8	7.29	2	
63 1940.....	23 7.9	64 11	7.22	B5	7.00	3	S
64 1773.....	23 8.4	64 16	7.27	Ao	7.07	5	S
62 2109.....	23 9.7	62 42	.....	Ao	8.20	2	
61 2405.....	23 9.8	61 40	.....	A	8.13	6	
64 1779.....	23 10.8	64 53	7.10	F2	7.53	5	
64 1780.....	23 11.0	64 28	7.67	F5	7.71	5	
73 1023.....	23 11.1	73 41	5.74	Ao	6.01	9	S P.D.M.=6.16
63 1955.....	23 11.3	63 34	7.52	Fo	7.55	3	
70 1311.....	23 11.8	70 20.5	5.62	A3	5.91	10	S P.D.M.=5.79
64 1781.....	23 11.8	64 16	.....	Ao	8.18	4	
70 1312.....	23 12.2	70 16	8.09	Ao	8.17	10	
63 1960.....	23 12.2	63 34	7.52	Fo	7.55	3	
61 2413.....	23 12.2	61 25	6.49	B8	6.38	4	S
74 1016.....	23 13.8	74 45	6.44	A2	6.45	4	S
72 1096.....	23 14.3	73 08	7.28	Ko	8.31	9	

CATALOGUE—*Continued*

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
67° 1514.....	23 ^h 14 ^m 5	67° 34'	4.90	G5	5.96	10	
60 2521.....	23 15.6	60 36	6.82	B5	6.50	7	S
64 1787.....	23 15.8	64 18	7.17	Fo	7.28	4	
73 1027.....	23 15.9	73 23	.....	Fo	7.70	9	
63 1974.....	23 16.9	64 12	7.17	B9	7.12	4	S
63 1978.....	23 17.7	63 58	7.92	Ao	7.59	3	S
70 1315.....	23 17.8	70 59	.....	F2	8.15	10	
66 1603.....	23 18.3	66 31	.....	F	8.43	3	
63 1988.....	23 20.2	63 18	6.76	Ko	7.64	3	
61 2444.....	23 20.4	61 44	5.20	K5	6.57	7	
65 1887.....	23 20.6	65 39	.....	Fo	8.39	2	
68 1376.....	23 21.4	68 24	7.02	Ko	7.84	8	
66 1607.....	23 21.4	66 22	7.60	Ao	7.43	9	S
69 1331.....	23 22.0	70 08	6.74	A2	6.71	10	
67 1525.....	23 22.5	67 19	.....	A5	8.18	7	
63 1995.....	23 22.5	63 41	.....	Ao	7.74	3	
63 1996.....	23 22.6	64 04	.....	Ao	8.08	2	
64 1810.....	23 22.9	65 04	7.00	Ko	7.65	5	
69 1332.....	23 23.0	69 49	5.63	A2	5.98	10	S
64 1811.....	23 23.6	64 50	.....	Ao	8.20	4	
73 1035.....	23 23.7	73 34	7.17	Fo	7.45	9	
74 1022.....	23 25.0	74 40	6.54	Ao	6.67	5	S P.D.M.=6.84
63 2004.....	23 26.0	63 50	7.26	A5	7.20	2	S
63 2006.....	23 26.2	63 47	.....	A3	8.18	2	
61 2462.....	23 26.2	61 45	.....	Ao	7.25	7	
64 1819.....	23 27.7	65 11	6.62	Fo	6.80	5	
71 1208.....	23 28.2	71 27	6.64	A2	6.73	13	S P.D.M.=6.92
64 1825.....	23 29.1	64 39	.....	A2	8.40	3	
66 1615.....	23 29.5	67 65	.....	A3	8.24	5	
72 1109.....	23 29.8	72 22	7.24	A2	7.44	11	S P.D.M.=7.50
70 1327.....	23 30.6	71 05	6.13	Ko	7.56	11	
66 1619.....	23 30.6	66 56	7.40	Ko	8.18	7	
66 1621.....	23 31.2	66 28	.....	A2	8.30	4	
66 1622.....	23 31.3	66 19	.....	Go	8.34	4	
67 1542.....	23 32.0	67 18	7.20	Ao	7.11	9	S
70 1329.....	23 33.1	70 32	.....	F5	8.58	7	
67 1547.....	23 33.2	67 23	.....	F5	8.27	7	
69 1342.....	23 33.9	70 05	8.24	A3	8.18	7	
61 2400.....	23 34.1	61 35	6.72	A2	6.87	9	S
74 1032.....	23 34.9	74 44	.....	A2	6.26	6	
71 1218.....	23 34.9	71 24	.....	Ao	7.73	10	
73 1047.....	23 35.0	73 27	6.08	G5	6.89	9	
64 1836.....	23 35.2	64 16	8.00	Ao	8.09	4	S
66 1030.....	23 35.8	67 00	.....	F8	8.32	3	
64 1838.....	23 36.5	64 34	7.76	Ko	8.41	3	

CATALOGUE—Continued

B.D. No.	R.A. 1900	Dec. 1900	H.R. Mag.	H.D. Sp.	Ptg. Mag.	No. Pl.	Remarks
67° 1557.....	23 ^h 37 ^m 2	68° 07'	.....	A0	7.50	6	
60 2609.....	23 37.7	61 07	6.54	K2	7.51	10	
73 1052.....	23 37.8	73 34	.....	B9	7.90	9	
68 1391.....	23 39.1	68 31	.....	F5	8.19	6	
68 1393.....	23 40.3	69 12	7.03	B8	6.96	9	S
63 2051.....	23 41.7	63 45	7.42	G5	8.32	5	
65 1943.....	23 41.8	66 13	5.94	B3	5.86	8	
63 2054.....	23 42.6	63 35	7.86	B9	7.71	5	S
70 1334.....	23 43.0	70 56	7.66	K0	8.24	14	
67 1562.....	23 43.1	67 15	5.02	A0	5.27	9	S P.D.M. = 5.26
65 1946.....	23 43.3	65 43	8.50	A0	8.38	4	
61 2533.....	23 44.0	61 40	5.61	A2p	5.76	6	S
73 1061.....	23 44.1	74 10	.....	F5	8.67	7	
68 1402.....	23 45.5	68 57	.....	F8	8.37	5	
66 1647.....	23 45.5	66 21	7.21	F2	7.48	9	
63 2064.....	23 46.1	63 26	6.76	A0	6.78	4	S
61 2551.....	23 47.4	61 19	7.31	F0	7.61	6	
74 1047.....	23 47.5	74 59	6.55	K2	7.39	5	
60 2630.....	23 48.9	60 18	6.98	B0	7.30	6	
60 2637.....	23 49.2	61 03	7.56	B0	7.63	6	
64 1875.....	23 49.3	65 13	8.35	A0	8.10	7	
66 1654.....	23 49.4	66 16	.....	A5	8.36	5	
62 2323.....	23 49.4	62 38	.....	A0	8.52	4	
61 2562.....	23 49.7	61 17	7.16	B0	7.50	6	
73 1063.....	23 50.0	73 51	6.57	B9	6.56	8	S
69 1369.....	23 50.2	70 11	8.94	A	8.94	2	
74 1051.....	23 50.4	74 19	7.84	K0	8.86	7	
69 1370.....	23 50.7	70 07	8.69	A0	8.49	7	
72 1127.....	23 52.4	72 18	.....	B5	7.57	9	
61 2573.....	23 52.5	61 27	7.46	A0	7.42	8	
73 1067.....	23 52.6	73 19	.....	F5	7.85	9	
66 1662.....	23 53.0	66 42	.....	A0	8.15	8	
69 1373.....	23 53.2	70 01	8.29	G0	8.33	6	
68 1414.....	23 53.5	68 47	.....	F0	8.04	9	
66 1667.....	23 53.9	66 15	.....	F5	8.13	7	
64 1883.....	23 54.1	64 20	.....	A3	8.21	5	
73 1068.....	23 54.2	74 15	7.92	A3	7.93	8	S
71 1244.....	23 54.9	72 04	.....	K0	8.22	10	
65 1979.....	23 55.2	65 23	8.40	F	8.33	5	
67 1586.....	23 55.3	67 18	.....	A3	7.80	9	
61 2580.....	23 55.6	61 37	7.05	G0	7.22	8	
70 1341.....	23 56.2	70 22	7.69	F0	7.73	10	
60 2656.....	23 56.3	60 17	7.36	B5	6.91	8	S
72 1135.....	23 56.5	73 03	6.52	A0	6.71	9	S P.D.M. = 6.75
71 1246.....	23 56.5	71 41	7.51	K0	8.22	10	

CATALOGUE—*Continued*

<i>B.D. No.</i>	<i>R.A. 1900</i>	<i>Dec. 1900</i>	<i>H.R. Mag.</i>	<i>H.D. Sp.</i>	<i>Ptg. Mag.</i>	<i>No. Pl.</i>	<i>Remarks</i>
60° 2657.....	23 ^h 56 ^m 5	60° 40'	5.70	A5	5.75	8	S
65 1984.....	23 56.7	65 45	7.45	Ko	7.84	6	
64 1887.....	23 56.7	64 54	7.85	F5	7.82	7	
65 1985.....	23 56.9	65 53	7.30	B9	7.18	6	
62 2351.....	23 56.9	62 47	.....	Ao	8.25	3
72 1136.....	23 58.2	72 37	7.52	A2	7.36	11	S
62 2356.....	23 58.3	63 05	6.26	B1	6.41	3	
61 2586.....	23 59.1	61 44	6.00	Ao	5.88	6	
69 1379.....	23 59.7	70 14	8.54	Ao	8.33	9	
65 1994.....	23 59.7	65 17	8.25	Ao	8.14	8	
65 1995.....	23 59.8	65 58	F5	8.41	2	
64 1894.....	23 59.8	64 52	7.50	Ko	8.07	8	
63 2103.....	23 59.8	64 13	.....	F5	8.23	5
60 2667.....	23 59.9	60 46	5.87	B9	5.39	5	

A STUDY OF THE WIDTHS OF THE LINES IN THE B BAND, DUE TO ATMOSPHERIC OXYGEN, IN THE SOLAR SPECTRUM¹

BY R. VAN DER RIET WOOLLEY

ABSTRACT

Widths of the lines in the B band in the solar spectrum have been measured. An *observational test of the relation between line width and number of atoms* forming the line was made by comparing the widths of the lines at different solar zenith distances. The measurements show a *definite departure from Unsöld's formula*, in which the width is proportional to the one-half power of the number of atoms. These observations show that the width is approximately proportional to the three-eighths power.

INTRODUCTION

At the suggestion of Mr. Babcock the writer has measured the relative widths of lines in the B band in the solar spectrum. This band is formed by absorption of light by oxygen molecules in the earth's atmosphere. The relative widths of 28 lines in the band can be determined with some accuracy. As far as is known, the present observations are the first measures of relative widths in a band spectrum.

It occurred to the writer that the diurnal changes in the widths of the lines in this band afford an excellent opportunity for making an observational test of the relation between the width of an absorption line and the number of atoms concerned in its formation. For these lines, the number of atoms is proportional to the air path, which can be taken to be proportional to the secant of the sun's zenith distance for values of the secant less than 10. When the secant exceeds this limit, the air path is uncertain.

Let r be the ratio of the intensity of the light at some point inside an absorption line to the intensity of the continuous background just outside the line. The width of the line measured at some definite value of the parameter r is related to the number of atoms concerned in the formation of the line. In the case of a solar or stellar line the "number of atoms" referred to is the number above a certain optical depth, and in the case of an atmospheric or laboratory absorption

¹ *Contributions from the Mount Wilson Observatory, Carnegie Institution of Washington*, No. 420.

line it is, of course, the actual number of absorbing atoms. In either case the relation between the width of the line and the number of atoms depends only on the form of the selective absorption coefficient of the line, expressed as a function of the frequency of the light absorbed; and this relation holds for both telluric and solar lines.

Let l_ν be the coefficient of line absorption. Any model of the solar atmosphere, such as Eddington's or Milne's, will give an expression for $r(\nu)$ of the type

$$r(\nu) = f\left(\frac{al_\nu}{k}\right),$$

where k is the actual coefficient of continuous absorption of the atmosphere and a is an abundance factor¹—that is, the number of atoms in the state which absorbs the line above any particular optical depth is proportional to a .

There will be an inverse relation,

$$\frac{al_\nu}{k} = \phi(r(\nu)).$$

Observations at a definite point $r(\nu) = r_1$ give us an observed width $\nu_1 - \nu_0$, for which

$$a = \frac{k\phi(r_1)}{l_{\nu_1}}.$$

The number of atoms is therefore inversely proportional to l_{ν_1} , and the relation between the number of atoms and the width $\nu_1 - \nu_0$ depends only on the form of l_ν . The relation is even simpler in the case of a Schuster type of scattering in which there is no continuous absorption. In this case

$$r(\nu) = \frac{1}{1 + N M l_\nu},$$

where N is the actual number of atoms and M the mass of each. We thus have

$$N = \frac{1}{M l_{\nu_1}} \left(\frac{1}{r_1} - 1 \right).$$

¹ Cf. Woolley, *Monthly Notices of the Royal Astronomical Society*, **90**, 185 n., 1929.

In the case of a truly absorptive atmosphere, where none of the light is scattered and all the energy is converted into heat, we have

$$r(\nu) = e^{-NMl_\nu}$$

and

$$N = \frac{1}{l_\nu M} \log_e \frac{1}{r}.$$

In every case

$$N \propto (l_\nu)^{-1}.$$

An expression for l_ν as a function of ν has been given by Unsöld.¹ This is

$$l_\nu = \frac{2\pi e^4 \nu_0^2 f}{3Mm^2 c^4 (\nu - \nu_0)^2},$$

where M is the mass of the atom, e and m the charge and mass of the electron, and f the "oscillator strength" of the line under consideration. This formula, of course, breaks down near the central frequency $\nu = \nu_0$. From what has been said above it follows that measurements of the width of an atmospheric line afford a direct test of Unsöld's formula, which gives $(\nu_1 - \nu_0)^2$ proportional to the number of atoms in the air path, that is, to $\sec z$, where z is the sun's zenith distance.

Unsöld has tested this formula observationally on some very strong lines (H and K, the D lines, etc.), and the agreement between observation and theory was considered satisfactory. The peculiar strength which weaker members of multiplets appear to exhibit in the solar spectrum² has, however, cast some doubt upon the applicability of the formula to weaker lines.

The Doppler effect modifies the form of l_ν . For solar lines this influence becomes important in the case of lines whose Rowland number ≤ 2 . In the earth's atmosphere the temperature is very much lower, and the Doppler effect is utterly negligible within the range of widths covered by the lines here measured. Similarly, these

¹ *Zeitschrift für Physik*, **44**, 793, 1927.

² Minnaert, *Zeitschrift für Astrophysik*, **1**, 192, 1930; Woolley, *Mt. Wilson Contr.*, No. 413; *Astrophysical Journal*, **72**, 256, 1930.

lines are so wide that the finite resolving power of the instrument does not affect measurements of their width.

The possibility remains of a pressure broadening in the earth's atmosphere. This band has been observed in the laboratory with an air path of about 10 meters at atmospheric pressure. Under these circumstances the lines appear very sharp as compared with the same lines in the solar spectrum.¹ It is therefore evident that in the latter case we are dealing with abundance broadening.

TABLE I
OBSERVATIONS OF WIDTHS IN MILLIANGSTROMS FROM
 λ 6908 TO λ 6920

SPECTRO- GRAM	λ 6908		λ 6909		λ 6913		λ 6914		λ 6914 Ni		λ 6918		λ 6919		SEC z
	9/10	3/4	9/10	3/4	9/10	3/4	9/10	3/4	9/10	3/4	9/10	3/4	9/10	3/4	
f.....	189	108	187	108	160	082	133	078	135	059	114	064	117	064	1.69
g.....	178	101	187	108	153	076	135	076	124	041	119	062	124	057	1.70
h.....	222	135	232	133	160	107	160	107	142	059	151	080	146	080	2.40
i.....	258	160	258	164	162	089	167	091	124	...	172	096	178	096	4.36
j.....	285	178	320	205	214	124	*	*	142	...	196	107	214	114	6.13
k.....	320	214	392	222	285	178	*	*	160	071	267	152	*	*	9.80
m.....	358	232	427	214	267	178	*	*	142	080	214	151	*	*	9.52
n.....	285	196	338	204	232	169	*	*	142	...	204	128	*	*	6.81
o.....	279	178	276	174	196	128	204	137	142	071	160	...	160	...	4.39
p.....	268	151	270	160	171	124	187	132	142	071	142	089	139	089	3.34
q.....	204	130	214	133	147	107	...	...	142	071	124	...	133	...	2.37
r.....	169	100	171	066	142	068	142	070	124	...	124	...	124	...	1.75

* Blended with atmospheric water-vapor lines at low sun.

OBSERVATIONS

Twelve good spectrograms were obtained with the 150-foot solar tower in the first order of the 75-foot spectrograph. The plates are Ilford special rapid panchromatic; the developer, Kodak formula D 61. The method of standardization has been described in *Contribution* No. 413.²

All the spectrograms were measured in the region $\lambda\lambda$ 6908-6920, within which occur six lines of the band and a solar nickel line of Rowland intensity 4. The widths in milliångstroms of these seven lines at $r=9/10$ and at $r=3/4$ are shown in Table I, which also gives the values of sec z . The reduction of these measures is shown in

¹ I am indebted to Mr. Babcock for this information from his unpublished material.

² Woolley, *Astrophysical Journal*, 72, 256, 1930.

Table II. The mean widths are given in the columns headed "Reduced" and "Unreduced." The unreduced values are the means of

TABLE II
REDUCTION OF MEASUREMENTS FROM λ 6908 TO λ 6920

SPECTRO- GRAM	MEAN WIDTH				MEAN OF REDUCED AND UNREDUCED		LOG SEC z SEC z_f	LOG (MEAN WIDTH) ²
	$r=9/10$		$r=3/4$		$r=9/10$	$r=3/4$		
	Reduced	Unreduced	Reduced	Unreduced				
<i>f</i>	100	100	100	100	100	100	0.000	0.000
<i>g</i>	108	100	104	96	104	100	.000	.016
<i>h</i>	114	120	121	127	117	124	.158	.158
<i>i</i>	146	134	149	137	140	143	.423	.298
<i>j</i>	154	162	160	160	158	164	.567	.417
<i>k</i>	165	195	184	218	180	201	.769	.558
<i>m</i>	184	194	203	213	189	208	.748	.594
<i>n</i>	158	164	184	194	161	189	.602	.486
<i>o</i>	132	141	153	161	137	157	.413	.334
<i>p</i>	121	127	137	144	124	140	.299	.242
<i>q</i>	102	108	118	124	106	121	.170	.106
<i>r</i>	108	99	97	89	103	93	0.017	-0.016

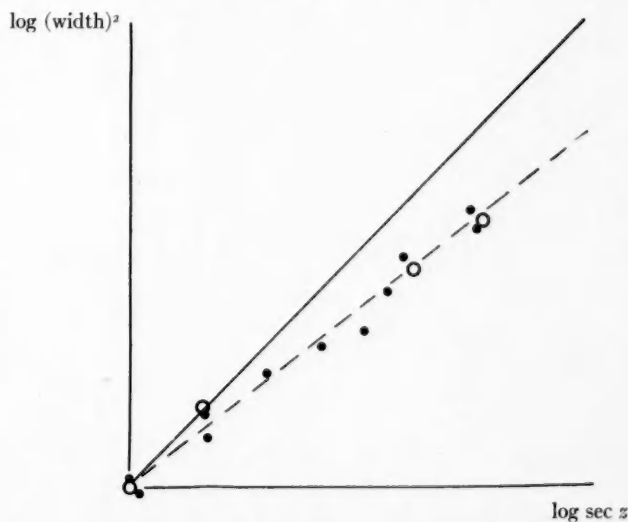


FIG. 1.—Log (mean width)² plotted against log sec z . The unbroken line represents Unsöld's formula.

the ratios of the width of each of the six lines of the band to the width of the corresponding line in spectrum *f*. A certain amount of

systematic error can be eliminated by taking into account variations in the width of the nickel line. If we suppose that all the change in the observed width of this line is due to an error in fixing the position

TABLE III
OBSERVATIONS OF WIDTHS IN MILLIANGSTROMS FROM
 λ 6872 TO λ 6920

λ	r		k		j		h	
	9/10	3/4	9/10	3/4	9/10	3/4	9/10	3/4
6872.26.....	178	125	*	.....	*	.....	205	147
6872.86.....	222	142	.....	.....	.....	.....	250	169
6873.81.....	196	128	.....	.....	.....	.....	222	151
6874.66.....	214	137	.....	.....	.....	.....	240	164
6875.60.....	196	126	.....	.....	.....	.....	240	160
6876.73.....	192	126	.....	.....	.....	.....	232	157
6877.65.....	172	109	.....	.....	.....	.....	214	137
6879.05.....	181	112	.....	.....	294	189	222	153
6879.94.....	100	073	276	178	222	139	141	080
6883.84.....	178	112	330	232	267	187	232	128
6885.77.....	196	117	†	250	320	199	222	142
6886.75.....	232	139	463	317	445	267	262	164
6888.96.....	201	132	†	302	356	232	267	162
6889.91.....	232	146	500	356	428	292	294	178
6892.38.....	222	141	†	302	392	250	276	173
6893.32.....	235	151	535	342	428	285	294	189
6896.05.....	226	137	†	302	356	232	267	178
6896.98.....	232	142	525	338	428	280	285	183
6899.97.....	205	128	410	276	302	214	250	149
6900.88.....	222	137	481	312	392	250	285	169
6904.13.....	192	112	374	249	285	196	221	132
6905.04.....	205	115	†	303	356	240	205	137
6908.55.....	169	100	320	214	285	178	222	135
6909.45.....	171	105	392	222	320	205	232	133
6913.21.....	142	066	285	178	214	125	160	107
6914.10.....	142	068	†	†	†	†	160	107
6918.14.....	125	.....	267	151	196	107	151	080
6919.02.....	125	.....	†	151	214	114	146	080

* At low sun the lines in the R branch blend together and are not measurable.

† Blended with atmospheric water vapor at low sun.

of the ordinate $r=9/10$ on the microphotometer tracing, the corresponding systematic error can be eliminated by multiplying the unreduced mean by the ratio of the observed width of the nickel line in spectrum f to its observed width in the spectrum under consideration. The results of this correction are the "reduced" means. Since only about one-half of the error in observing the width of the nickel line is systematic, I have used the means of the reduced and unre-

duced values. The values of $\log (\text{mean width})^2$ are plotted against $\log \sec z$ as small circles in Figure 1.

Four spectrograms, r, k, j, h , were then selected on account of the fact that the photographic densities of their continuous backgrounds are approximately equal, a circumstance which tends to eliminate

TABLE IV
REDUCTION OF MEASUREMENTS FROM λ 6886 TO λ 6920
(Width of lines in spectrogram $r=100$)

λ	k		j		h	
	9/10	3/4	9/10	3/4	9/10	3/4
6885.77.....	184	212	164	170	114	122
6886.75.....	200	226	.....	192	113	118
6888.90.....	204	230	177	176	133	123
6889.91.....	215	244	185	.....	127	122
6892.38.....	192	215	176	177	119	118
6893.32.....	226	225	182	188	125	124
6896.05.....	182	220	158	169	118	130
6896.98.....	227	237	185	196	123	129
6899.97.....	200	215	148	169	122	116
6900.88.....	216	227	176	182	128	124
6904.13.....	104	222	148	174	114	118
6905.04.....	Blend	261	174	208	100	118
6908.55.....	189	214	168	178	132	.....
6909.45.....	230	212	188	195	135	.....
6913.21.....	200	270	150	189	112	.....
6914.10.....	Blend	.....	Blend	Blend	112	.....
6918.14.....	214	.....	157	.....	122	.....
6919.02.....	Blend	Blend	172	.....	118	.....
Mean.....	210	223	163	182	120	124
$\log (\text{width})^2$	216 0.668		173 0.470		122 0.172	
$\log \sec z$	0.768		0.566		0.158	

systematic errors in comparing widths derived from different spectrograms. Measures of these spectrograms from λ 6872 to λ 6920 are shown in Table III. The widths of the lines for the different values of $\sec z$ are given in Table IV, expressed in terms of the width of the same line in spectrum r taken as 100. No correction was made for differences in the width of the nickel line. The values of the $\log (\text{mean width})^2$ are plotted against $\log \sec z$ in Figure 1 (large circles). The agreement between the two sets of reductions is highly satisfactory.

These measurements show that the widths of the lines are ap-

proximately proportional to the three-eighths power of the number of atoms in the air path. The deviation from the line given by Unsöld's theory is small but perfectly definite. A larger deviation in

TABLE V
RELATIVE WIDTHS OF LINES IN THE B BAND AT CONSTANT z

QUANTUM CLASSIFICATION	λ	r		k		j		h		MEANS				MEAN	P.E.
		9/10	3/4	9/10	3/4	9/10	3/4	9/10	3/4	9/10	3/4				
R_1	10.....	6872.26	76	82	Blend	Blend	Blend	Blend	70	78	73	80	76	3	
	8.....	6873.81	84	85	Blend	Blend	Blend	Blend	76	80	80	82	81	3	
	6.....	6875.60	84	84	Blend	Blend	Blend	Blend	82	85	83	85	84	1	
	4.....	6877.65	74	72	Blend	Blend	Blend	Blend	73	73	73	73	73	$\frac{1}{2}$	
	2.....	6879.94	46	48	52	52	52	49	48	47	49	49	49	2	
R_2	8.....	6872.86	95	94	Blend	Blend	Blend	Blend	91	90	93	92	93	2	
	6.....	6874.66	91	91	Blend	Blend	Blend	Blend	82	87	87	89	88	3	
	4.....	6876.73	82	83	Blend	Blend	Blend	Blend	79	83	81	83	82	1	
	2.....	6879.05	77	74	Blend	Blend	69	67	76	81	74	74	74	3	
	0.....	6883.84	76	74	62	68	63	66	79	68	70	69	70	5	
P_2	2.....	6885.77	83	78	*	73	75	70	76	76	77	74	76	3	
	4.....	6888.96	86	87	*	89	83	82	91	86	87	86	87	2	
	6.....	6892.38	95	93	*	89	92	88	94	92	94	91	93	2	
	8.....	6896.05	96	91	*	89	83	82	91	94	90	89	90	4	
	10.....	6899.97	87	85	77	81	71	75	85	79	80	80	80	4	
	12.....	6904.13	82	74	70	73	67	69	75	70	74	71	73	3	
	14.....	6908.55	72	66	60	63	67	63	76	72	69	66	68	4	
	16.....	6913.21	61	...	*	52	50	44	55	57	55	51	53	4	
	18.....	6918.14	53	...	50	44	46	38	52	43	50	41	46	4	
P_1	2.....	6886.75	98	92	87	93	104	94	89	87	94	92	93	4	
	4.....	6889.91	98	97	93	102	100	103	100	94	99	99	99	3	
	6.....	6893.32	100	100	100	100	100	100	100	100	100	100	100	...	
	8.....	6896.98	98	94	98	99	100	97	97	97	98	97	98	1	
	10.....	6900.88	95	91	90	92	92	87	97	90	94	90	92	2	
	12.....	6905.04	87	77	*	89	83	84	...	...	85	83	84	3
	14.....	6909.45	73	69	73	65	75	73	79	71	75	70	73	2	
	16.....	6914.10	61	...	*	*	*	*	57	57	59	57	58	2	
	18.....	6919.02	53	...	*	44	50	40	50	43	51	44	48	4	
Mean...		2.9													

* Blended with weak atmospheric water-vapor lines.

the same direction would account for the observed anomalies of the widths of lines in multiplets; as these are, however, considerably narrower than the oxygen lines here measured, a deviation from Unsöld's formula which increases with decreasing line width would account for all the observational facts.

The relative widths of the lines at any instant are of course independent of z . The widths of the lines, relative to that of the line $\lambda 6893 = 100$ taken from four spectrograms, are shown in Table V, which is derived from Table III. The classification is that of Babcock and Dieke. The mean relative width and the probable error of this mean are shown in the last two columns. The mean probable error is about 3 per cent of the width of $\lambda 6893$.

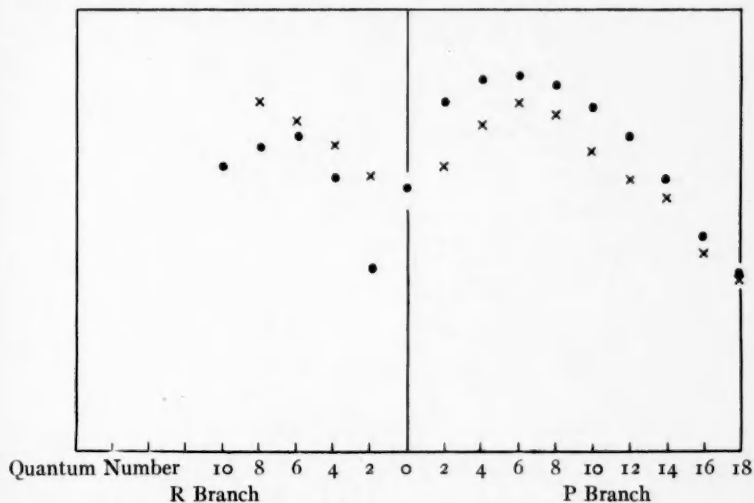


FIG. 2.—Relative widths of the lines in the B band plotted against quantum number. Dots, longer wave-length series $P_1(j)$ and $R_1(j)$. Crosses, shorter wave-length series $P_2(j)$ and $R_2(j)$.

These values are plotted in Figure 2. Unfortunately, as we go toward the violet in the R branch, the lines run together and begin to blend, even with a high sun, at the point where the observations stop, so that we are not able to observe the maximum, which stands out very clearly in the P branch.

My best thanks are due to Miss Ware for preparing the microphotometer tracings. I am indebted to the Commonwealth Fund for the opportunity to work at Mount Wilson.

CARNEGIE INSTITUTION OF WASHINGTON
MOUNT WILSON OBSERVATORY
December 1930

NOTE ON THE INTERPRETATION OF SPECTROPHOTOMETRIC OBSERVATIONS OF WEAK FRAUNHOFER LINES¹

By R. VAN DER RIET WOOLLEY

ABSTRACT

The legitimacy of inferring a number of atoms from observations of line width or of equivalent breadth of a weak Fraunhofer line is discussed with reference to a discordance between some recent observations and the Adams-Russell calibration of Rowland's scale intensities of solar lines. The effect of finite resolving power on the observations is considered, and some calculations of Doppler widening of lines are given. Finally, the theoretical possibilities of a modification of the Adams-Russell calibration, and of a breakdown of Unsöld's method when applied to weak lines, are discussed.

INTRODUCTION

The object of this note is to discuss whether the Adams-Russell calibration of Rowland's scale is affected by recent spectrophotometric observations of Fraunhofer lines which indicate anomalous behavior of the weaker lines in some multiplets.

The Adams-Russell calibration² of the Rowland scale depends on the assumption that the numbers of atoms performing the transitions connected with the formation of a multiplet of absorption lines are proportional to the numbers of atoms performing the same transitions when the atom concerned is in thermodynamic equilibrium with radiation. The calibration is independent of any measurements of line width except in so far as these measurements can be interpreted as providing definite information about the relative numbers of atoms performing the transitions.

A method of inferring numbers of atoms from measurements of line width has been developed, principally by A. Unsöld.³ The application of this method to some recent observations of the equivalent breadth⁴ of certain Fraunhofer lines by M. Minnaert and his col-

¹ Contributions from the Mount Wilson Observatory, Carnegie Institution of Washington, No. 421.

² Mt. Wilson Contr., No. 358; *Astrophysical Journal*, **68**, 1, 1928.

³ *Zeitschrift für Physik*, **44**, 795, 1927; **46**, 765, 1927; Stewart, *Astrophysical Journal*, **59**, 30, 1924.

⁴ The equivalent breadth of a line is the total amount of light removed from the continuous spectrum by the line. A line has an equivalent breadth of 1 Å if it removes an amount of light equal to that contained in 1 Å of the continuous spectrum in the neighborhood of the line.

laborators¹ and to measures of line widths by the present writer² gave the following result: In both cases the ratio of the number of atoms forming the weaker numbers of multiplets to the number forming stronger members is larger than the ratio given by the quantum theory. Ratios derived from the quantum theory, however, have in the main received confirmation from laboratory measurements and are the basis of the Adams-Russell calibration³ of Rowland's scale.

Further, a direct comparison of the Adams-Russell calibration with a calibration of Rowland's scale based on numbers of atoms deduced from observations of equivalent breadth and width shows a similar discordance. If we can set aside the two possibilities (1) that the observations are vitiated by the finite resolving power of the instruments used, and (2) that the discordance is caused by Doppler broadening of the weaker lines, we are faced with the following alternatives: (3) that the actual relative numbers of atoms in the solar photosphere performing the transitions in multiplets are not equal to the numbers given by the quantum theory and a straightforward application of conditions approximating to thermodynamic equilibrium (in this case the Adams-Russell calibration is incorrect); or (4) that the method developed by Unsöld is not valid for weak lines. In this case abnormal widths cannot be interpreted as due to abnormal numbers of atoms, and the Adams-Russell calibration of Rowland's scale is unaffected by the observations.

We examine these possibilities in detail.

I. FINITE RESOLVING POWER

Observations of equivalent breadth should be independent of resolving power. The best check of the effect of finite resolving power on measurements of width seems to be the observational method of determining the width of a line in different orders of a grating. In the writer's observations this was done for lines of Rowland num-

¹ *Zeitschrift für Physik*, **53**, 248, 1929; *Zeitschrift für Astrophysik*, **1**, 192, 1930.

² *Mt. Wilson Contr.*, No. 413; *Astrophysical Journal*, **72**, 256, 1930.

³ It should be mentioned that laboratory measures of multiplet intensities sometimes show serious departures from theoretical relations. The *Ti* multiplet in which the present writer found a discordance between solar and theoretical relative intensity is normal and shows no disagreement between laboratory measurements and theory.

bers 4 and 3. No discordance appeared between measures of various widths, down to 60 milliangstroms, in the third and second orders of the grating.

It does not seem likely that there are large instrumental errors in determinations in the case of lines whose Rowland number is 2 or greater. The agreement between the two deductions made from measurements of line width and of equivalent breadth confirms this view. It is, however, desirable to push instrumental checks still further.

2. DOPPLER EFFECT

In a previous paper¹ the writer has given an expression for the modification of the selective absorption coefficient produced by Doppler effect in an assembly of atoms whose velocities have a Maxwellian distribution in velocity corresponding to a temperature T .

Let s_ν be the coefficient of line absorption; in other words, if a monochromatic beam of frequency ν traverses unit length in the atmosphere, a fraction ρs_ν of the energy is scattered by the atoms concerned in the formation of the line, where ρ is the mass per unit volume of the atoms which are in a state suitable for the absorption of this line.

We take the form given by H. Lorentz:²

$$s_\nu = \frac{s_0}{1 + a^2(\nu - \nu_0)^2},$$

where $s_0 (= s_{\nu_0})$ and a are constants for any particular absorption line.

If f is the oscillator strength of the line, we have

$$\frac{s_0}{a^2} = \frac{2\pi e^4}{3Mm^2c^4} \nu_0^2 f,$$

$$\frac{s_0}{a} = \frac{e^2}{Mmc} f,$$

whence s_0 and a can be calculated.

¹ *Monthly Notices of the Royal Astronomical Society*, **90**, 170, 1929.

² *Proceedings of the Amsterdam Academy*, **18**, 134, 1916.

For the scattering coefficient s'_ν modified by the Doppler effect we find, after some reduction from a formula given in *loc. cit.*,

$$s'_\nu = \frac{s_0}{a^2(\nu - \nu_0)^2} \sqrt{\frac{4}{\pi}} \int_0^d x^2 e^{-x^2} dx + \frac{s_0 c}{a \nu_0} \left(\frac{\pi M}{2RT} \right)^{\frac{1}{2}} e^{-d^2},$$

where R is Boltzmann's constant, M the mass of the atom concerned, and

$$d = c \left(\frac{\nu - \nu_0}{\nu_0} \right) \sqrt{\frac{M}{2RT}}.$$

Table I gives values of s'_ν/s_ν calculated for $T = 6000^\circ \text{K}$, $\lambda_0 = 4500 \text{ \AA}$, and $M = 50 H$, where H is the mass of the hydrogen atom. With this value of M the calculations can be applied to iron and ti-

TABLE I
DOPPLER MODIFICATION OF THE SCATTERING COEFFICIENT

$\lambda - \lambda_0$ in milliangstroms	45	53	67	78	106
s'_ν/s_ν	31	5.2	1.27	1.003	1.000

tanium lines in the sun. This table shows that the Doppler effect begins seriously to modify the widths of lines when $\lambda - \lambda_0$ becomes less than 70 milliangstroms, that is, in the wings of a line whose Rowland number is 2 or less.

It is of interest to construct theoretical contours of weak lines. This may be done on the basis of Eddington's model, with the equation

$$r(\nu) = \frac{1 + \frac{2}{3}q}{1 + \eta + \frac{2}{3}q},$$

where $r(\nu)$ = the ratio of the intensity at a point inside the line to the intensity of the continuous background just outside the line. Further,

$$q^2 = 3(1 + \eta)(1 + \epsilon\eta),$$

where ϵ is the fraction of the absorbed energy which is converted into heat by superelastic collisions, and

$$\eta = \frac{as'_\nu}{k},$$

in which k is the coefficient of continuous absorption and α the ratio of the mass per unit volume of the atoms in the state by which the line is absorbed to the density of the atmosphere. The values of s'_ν are given in Table II. Taking $\epsilon = 1/100$, we compute the following contours for various values of $k/\alpha f$. Values of r , calculated for different values of $\lambda - \lambda_0$, are given in Table III.

TABLE II
VALUES OF THE MODIFIED SCATTERING COEFFICIENT s'_ν

$\lambda - \lambda_0$	000		10		20		30		
s'_ν	1.82	10^{11}	1.10	10^{11}	6.75	10^{10}	1.82	10^{10}	
$\lambda - \lambda_0$	45		53		67		78		
s'_ν	6.2	10^8	7.3	10^7	1.1	10^7	6.5	10^6	10^6

The contours are shown in Figure 1. Table IV gives the widths of the lines, that is, the values of $\lambda - \lambda_0$ for which $r = 9/10$ and the equivalent breadths of the lines measured from the contours with a planimeter. The values of $\log N$, in this case the logarithm of $\alpha f/k$, and

TABLE III
CONTOURS OF LINES MODIFIED BY DOPPLER EFFECT

APPROXIMATE ROWLAND NUMBER	$\frac{k}{\alpha f}$	$\lambda - \lambda_0$ IN MILLIANGSTROMS								
		0	10	20	30	45	53	67	78	10^6
+1.5	10^8	0.10	0.11	0.12	0.13	0.40	0.78	0.95	0.97	0.98
0	10^9	0.13	0.14	0.17	0.26	0.80	0.97	0.995	1.00	1.00
-2	10^{10}	0.26	0.32	0.38	0.62	0.98	1.00	1.00	1.00	1.00
-3	10^{11}	0.62	0.71	0.79	0.91	1.00	1.00	1.00	1.00	1.00

the values of $\log J_1$ and $\log J_2$, which are twice the logarithms of the widths and breadths, respectively, are also given.

These calculations show that the thermal Doppler effect seriously affects the deductions to be made from measurements of lines whose Rowland number is less than 2. Narrow lines are widened relative to stronger lines, an effect similar to the observational result that is the main subject of the present discussion.

It becomes pertinent to ask whether, although the thermal Doppler effect does not affect lines of Rowland number 2-3 or greater,

there may not be an increased Doppler effect due to turbulent motion in the photosphere. Table IV answers this question in the negative. If there were such a turbulent Doppler effect, the lines would decrease in width with decreasing Rowland number even more

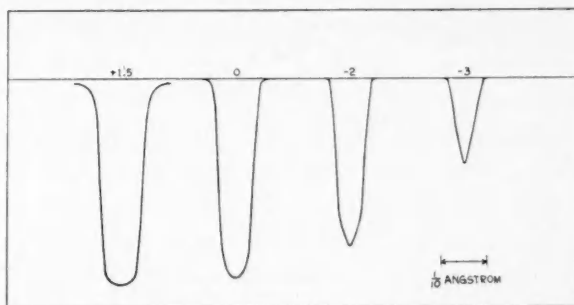


FIG. 1.—Calculated contours of weak lines, showing Doppler modification

slowly than they are observed to do, and there would be a discordance between the values of $\log J_1$ determined from relative widths and those of $\log J_2$ determined from equivalent breadth. As it is,

TABLE IV
WIDTHS AND EQUIVALENT BREADTHS OF LINES MODIFIED
BY DOPPLER EFFECT

k/af	10^8	10^9	10^{10}	10^{11}
$\lambda - \lambda_0$ (at $r=9/10$) in milliangstroms.	60	50	38	28
Equivalent breadth in angstroms.	0.088	0.068	0.044	0.017
$\log N$	0	-1	-2	-3
$\log J_1 = \log (\text{width})^2$	0	-0.16	-0.40	-0.66
$\log J_2 = \log (\text{equiv. breadth})^2$	0	-0.22	-0.60	-1.43

there is general agreement between the two methods for lines of Rowland number greater than 1.

Apparently, therefore, neither finite resolving power nor the Doppler effect can seriously affect deductions from measurements of lines whose Rowland number is greater than 2. Nevertheless there is a sufficient corpus of observations of multiplet and other lines stronger than this limit definitely to establish the existence of the effect under discussion.

3. POSSIBILITY OF FAILURE OF ADAMS-RUSSELL
CALIBRATION

We should accept the failure of the Adams-Russell calibration only if driven to it by conclusive evidence that none of the other causes is responsible for the observed discordance. On theoretical grounds, however, the possibility of a failure is not wholly excluded. In Eddington's classical paper¹ on the formation of absorption lines, two objections are raised to the assumptions underlying Unsöld's method, one of which, if substantiated, would also affect the basis of the calibration. This objection is Unsöld's neglect of the possibility of interlocking between different lines in a multiplet. Consider a weak line and a strong line in a multiplet which have the same upper state. When the atom absorbs a quantum of energy in either of these lines the electron moves into this upper state, from which it can move into either of the two lower states. There is a definite probability that it will choose to emit the stronger line, and this probability is equal to the ratio of the number of upward transitions connected with absorption of the stronger line to the number of upward transitions connected with absorption of the weaker line when the atom is exposed to a uniform continuous radiation. But if the atom is on top of the photosphere it is exposed to radiation which is deficient in light of the wave-lengths of these two lines, and since the stronger line is the blacker absorption line, it receives proportionately less of the radiation of this frequency, and the ratio of the numbers of upward transitions is disturbed in such a way that these transitions are relatively less frequent in the stronger line. The downward transitions take place in the same ratio as before, this ratio being an atomic constant. There is thus a transfer of radiation from the weaker absorption line to the stronger, and the interlocking effect tends to equalize all the lines corresponding to the same upper state of the atom. This strengthening of the weaker lines is brought about by an alteration of the relative numbers of atoms performing the transitions concerned, and if interlocking is the cause of the observed discordance, we must accept some modification of the Adams-Russell calibration.

¹ *Monthly Notices of the Royal Astronomical Society*, **89**, 621, 1929.

The writer has performed some calculations relative to a simple case of interlocking.¹ If these are correct and if they can be generalized in such a way as to apply to complicated multiplet systems, interlocking plays an unimportant part in the formation of absorption lines, as the process is practically restricted to a very thin layer of the photosphere and has a very small effect on the width of a line.

4. POSSIBILITY OF FAILURE OF UNSÖLD'S METHOD

In the same paper Eddington² points out that Unsöld's method assumes a certain mechanism as a means of accounting for the behavior of an atom performing selective absorption and re-emission, namely, that when an atom absorbs a quantum in the wings of a line, that is, a quantum of a frequency not exactly equal to the central frequency, it re-emits a quantum of exactly the same frequency as the frequency of absorption. If this postulate which Unsöld has adopted is incorrect, there is a possibility of failure in Unsöld's method.

Let us suppose that when an atom has absorbed a quantum of frequency ν_1 it does not necessarily re-emit a quantum of exactly the same frequency, but that there is a probability $p_{12}d\nu$ of re-emission with a frequency in the range ν_2 to $\nu_2 + d\nu$. The mechanism cannot disturb the detailed balancing of the thermodynamic equilibrium between the atom and radiation; therefore, if $N_1d\nu$ is the number of quanta absorbed from uniform radiation per second by the atom in the range ν_1 to $\nu_1 + d\nu$, and $N_2d\nu$ is the corresponding number in the range ν_2 to $\nu_2 + d\nu$, we must have $N_1p_{12} = N_2p_{21}$. Let us suppose that $|\nu_2 - \nu_0| > |\nu_1 - \nu_0|$, where ν_0 is the central frequency of the line. Then an atom near the top of the photosphere is exposed to radiation which is more deficient in ν_1 radiation than in ν_2 radiation, and if N'_1 , N'_2 refer to the numbers of quanta absorbed per second in the two frequencies by such an atom,

$$N'_2p_{21} > N'_1p_{12},$$

and there is a transfer of radiation from the wings to the center of the line and a tendency to broaden the absorption line.

Now if we suppose that the transfer is practically limited to a

¹ *Ibid.*, 90, 779, 1930.

² *Loc. cit.*

definite range $\Delta\nu$, such as would be the case if, for example, p_{12} were proportional to

$$\exp \left\{ - \left(\frac{\nu_2 - \nu_1}{\Delta\nu} \right)^2 \right\},$$

the effect on the width of the line would be considerable provided this width were comparable to $\Delta\nu$. The broadening due to this atomic redistribution in frequency decreases with increasing abundance-broadening of the line. The effect is somewhat similar to the apparent broadening of a line by an instrument of low resolving power, with the important difference, however, that the light transferred into the central frequency at points below the top of the photosphere will be scattered again, and the total intensity of the line as well as the width will be increased by the redistribution in frequency.

We have here a possible mechanism which broadens weak lines relative to stronger ones and invalidates Unsöld's rule for determining the number of atoms that perform the transitions in the formation of a weak line from measurements of its width or equivalent breadth.

Some observations conducted by the present writer¹ on the diurnal variations in the widths of telluric lines, whose mean Rowland numbers range from 15 to 10, indicate a definite departure from Unsöld's rule, according to which the width of a line is proportional to the square root of the number of atoms concerned in its formation. This departure is in the same direction as the observed discordance between the observations mentioned previously and the Adams-Russell calibration of Rowland's scale, although not of sufficient magnitude to account for all of it. The original observations of Unsöld,² which were made on very wide lines, indicated no departure from normal multiplet intensity as tested by his rule. Observations by O. Struve and C. T. Elvey³ on a wide triplet of *Si* III in stellar spectra indicate no abnormality. Minnaert's observations show a smaller discordance with the Adams-Russell calibration in the range of Rowland numbers 30-10 than in the range 10-1, while that in which the writer found discordance was 4-1.

¹ *Mt. Wilson Contr.*, No. 420; *Astrophysical Journal*, **73**, 185, 1931.

² *Loc. cit.*

³ *Astrophysical Journal*, **72**, 267, 1930.

If N is the number of atoms deduced for a line from the Adams-Russell calibration or, in the case of a multiplet line, the number given by the quantum theory, and if J is the number of atoms deduced from applying Unsöld's rule to an observation of the width or the equivalent breadth, then $\Delta \log J / \Delta \log N$ is a measure of the discordance. Table V shows the observed values of this quantity.

The value given by the writer's observations¹ on telluric lines of Rowland numbers 10-15 is 0.75. For this case N is the number of atoms in the air path. The observations, if we disregard Minnaert's determination of the equivalent breadths of lines of negative Row-

TABLE V
DISCORDANCES BETWEEN MEASURED AND THEORETICAL
NUMBER OF ATOMS

Authority	Rowland No.	$\frac{\Delta \log J}{\Delta \log N}$
Struve and Elvey.....	20 and greater	1.00
Minnaert.....	15-30	1.4*
Minnaert.....	20-30	1.0
Minnaert.....	1-6	0.62
Woolley.....	1-4	0.50

* The value 1.4 depends on the Rowland numbers assigned to the three lines in the Mg triplet and is therefore not of great weight. The value 1.0 is found by direct comparison of two of these lines with quantum-theory intensities.

land number, which depend on a very small number of lines measured, suggest a progressive deviation from Unsöld's formula that becomes greater as we pass from wider to narrower lines, whether owing to some mechanism, such as redistribution in frequency as suggested by Eddington and quoted above, or to some other cause.² If this is the case, the Adams-Russell calibration of the Rowland scale is not affected by the observations. At present it seems more reasonable to interpret the observations quoted above as an indication of a failure of Unsöld's method when applied to weak lines, rather than as a proof of anomalous behavior among multiplet transitions such

¹ *Mt. Wilson Contr.*, No. 420; *Astrophysical Journal*, 73, 185, 1931.

² It is somewhat doubtful whether the mechanism of redistribution can account for the behavior of telluric lines. Most of the absorption is performed at pressures so great that collisions are very frequent, and there may be no subsequent re-emission of the light selectively absorbed.

as would invalidate the Adams-Russell calibration of the Rowland scale. The point is of considerable importance, and further work is necessary before a pronouncement can be made definitely in favor of either alternative.

The writer is indebted to Professor H. N. Russell for valuable criticism of his work on the measurement and interpretation of line widths.

CARNEGIE INSTITUTION OF WASHINGTON
MOUNT WILSON OBSERVATORY
January 1931